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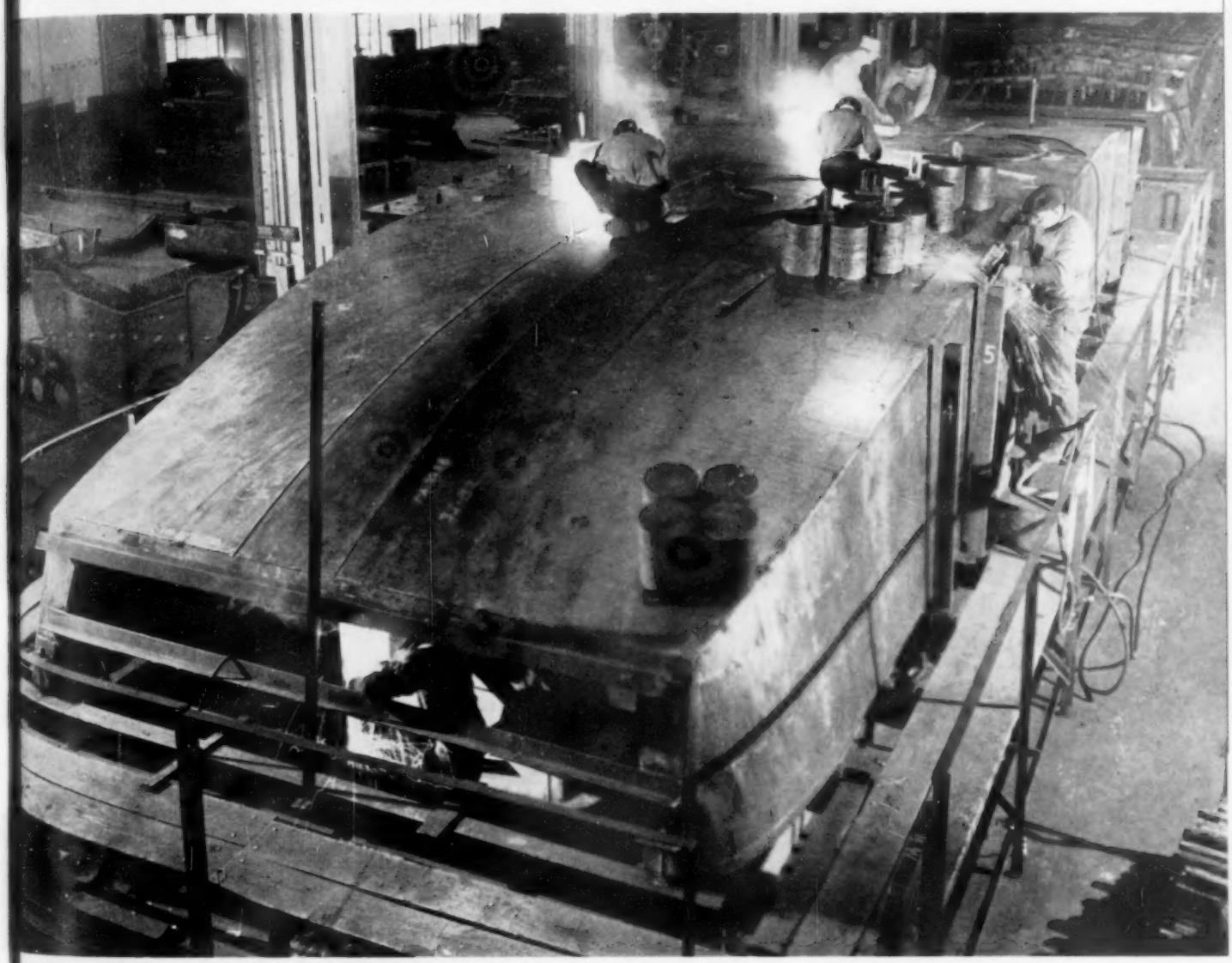

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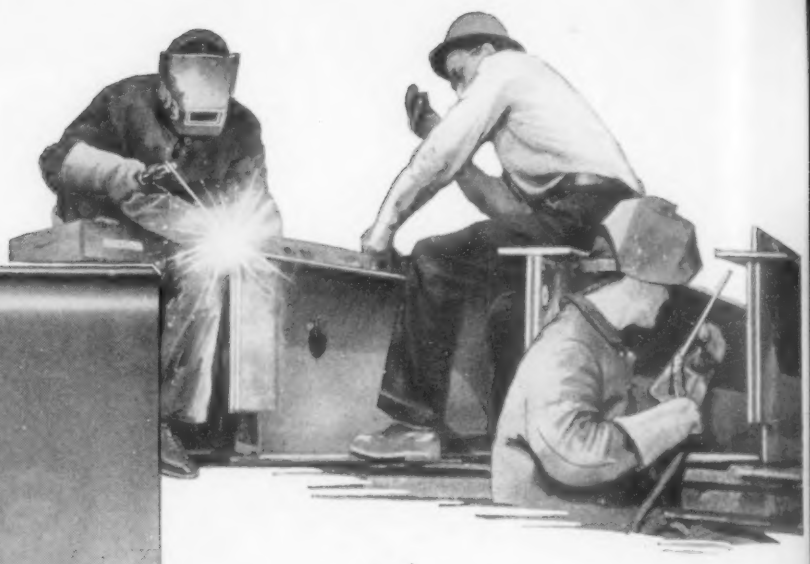

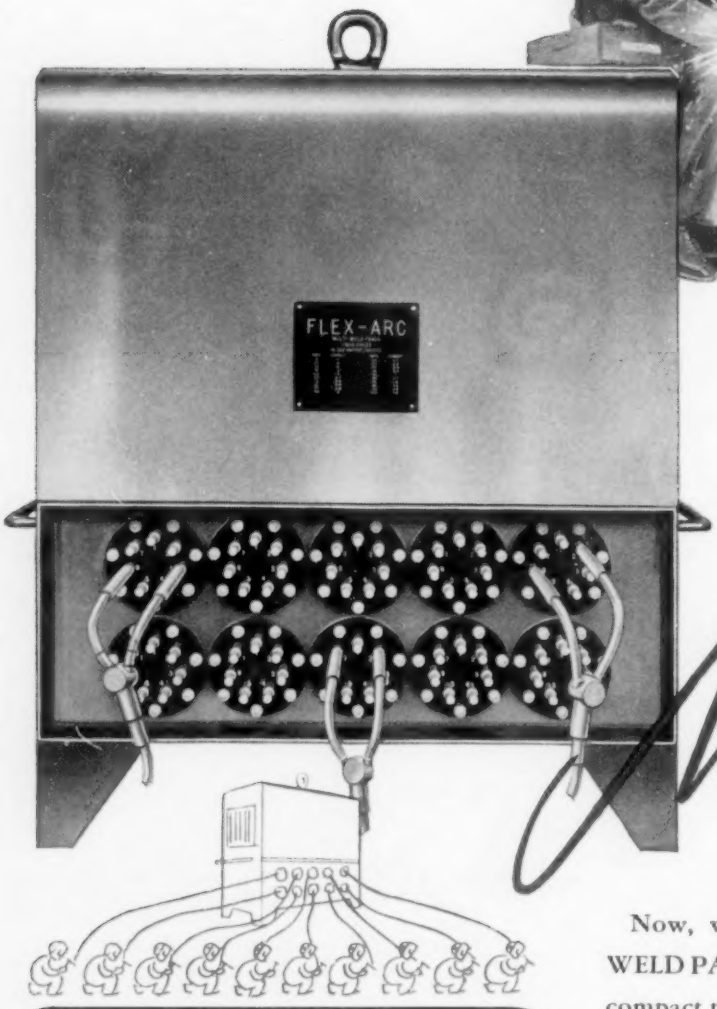

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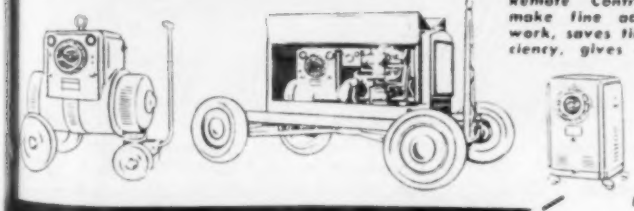

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COVER

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Test of ½-Continuous Welds to Replace 3-In. Intermittent Welds

By M. H. MacKusick*

Part I

THE welding of stiffeners, frames, floors, beams, etc., to ship plating ordinarily is specified as intermittent-weld increments of 3 in. in length, the size of fillet weld and spacing between welds being determined from Table A, Section 26 of the American Bureau of Shipping "Rules for Building and Classing Steel Vessels." The "Rules" also permit substitution of continuous welding as follows:

"Where it is desired to substitute continuous welding for intermittent welding as given in Table A, a reduction of $^1/_{16}$ in. from the required size of fillet may in general be allowed, but the actual sizes of the fillets are subject to approval in each individual case."

It has been proved in numerous tests that substitution of "continuous" fillets for intermittent-weld increment is economical only if the spacing of the increments is less than 8 in., and then only if the welding is done in the "down-hand position." Moreover, if the increment spacing is greater than 8 in., the substitution of continuous fillets $^1/_{16}$ in. less in leg measurement provides more than double the average strength required in the over-all length of the weld. It therefore appears logical to assume that a substitution for intermittent welds which are spaced 8 in. or greater, can be made $^1/_2$ of full continuous and the same, or greater equivalent over-all strength of attachment will be obtained with $^1/_{16}$-in. smaller welds.

Therefore, the following rule is proposed:

"Where intermittent welds in accordance with Table A, Section 26, are permitted, a substitution of continuous fillets $^1/_{16}$ in. less in leg size may in general be used for increment spacing of 8 in. or less. Where increment spacing is greater than 8 in., substitution of semicontinuous ($^1/_2$-continuous) welds of $^1/_{16}$ in. less in leg size may in general be used. A semicontinuous weld is defined as one in which fillet welding is deposited alternately on the opposite sides of a stiffener with not more than 18 in.

* Welding Engineer, California Shipbuilding Corp., Wilmington, Calif.

Fig. 1—Bulkhead *A* with $^3/_8$- x 3- x 10$^1/_2$-In. Intermittent Welds

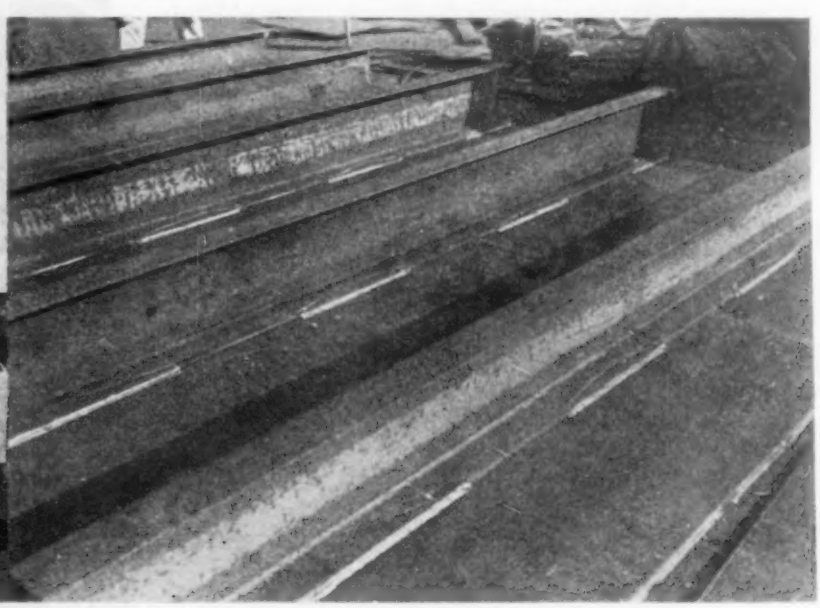


Fig. 2—Bulkhead *B* with $^1/_2$-Continuous $^5/_{16}$-In. Fillet Welds

maximum lengths of alternate deposits, the total weld being 1/2 of full continuous welding. End connections are to remain continuous for 1/10 of the length, in accordance with Note A of Table A.

In order to test the comparative value of 3-in. intermittent welds as against the proposed substitution of 1/2-continuous welds where spacing exceeds 8 in. two test bulkheads were fabricated and assembled into a "sandwich" for pressure testing.

Bulkhead *A* as shown in Fig. 1 was welded with 3/8- x 3- x 10 1/2-in. staggered welds, while bulkhead *B* as shown in Fig. 2 was welded using 1/2-continuous 5/16-in. welds (16-in. alternate welds). The welds may be seen in accompanying photographs. The standard 3-in. intermittent welds are shown in Fig. 1, while the 1/2-continuous welds on bulkhead *B* may be seen in Fig. 2. All welds were left as originally made and no repairing of small pinholes or slight undercuts was done. The 3-in. welds were made with two passes of 1/4-in. A.W.S. Type 6012 electrodes while the 1/2-continuous welds were made with 1/4-in. A.W.S. Type 6020 electrodes using the "Deep Fillet" procedure (10-in. burn-off per minute).

Weld	Arc Speed	
3/8- x 3-in. increment		
First pass	7	in./min.
Second pass	10	in./min.
Total weld	4 1/4	in./min.
5/16-in. x 1/2-continuous	10	in./min.
255 in. total length of 3/8-in. increment welds required		60 arc min.
480 in. total length of 5/16-in. 1/2-continuous welds required		48 arc min

In addition to the savings in total arc time the longer weld deposits are made by consuming a complete electrode without interruption while the 3-in. increments are made with numerous interruptions which tend to decrease the ratio of arc time to elapsed time, and in addition the average welder is inclined to waste more electrode in long stubs when making 3-in. weld increments.

The two test bulkheads were assembled together with 1/4-in. space between plating and seal welded all around the four edges. The stiffeners were placed on the outside of the assembly in Test No. 1. The ends of the stiffeners were welded continuous for 1/10 length and in addition clip plates were welded to connect the stiffeners on opposite bulkheads. The edges of the assembly were reinforced by driving C-clamps over the edges at 6 in. spacing and tack welding the C-clamps in place. See Figs. 3 and 4.

The assembly was then tested under pressure by pumping water between the two bulkheads. Water pressure was brought up to 25 psi. gage and held for deflection measurements. See Table 1 for deflection at 25 lb. (25 lb. gage equals a test head of 57 1/2 ft. of water). Pressure was then relaxed to zero gage and deflection was again checked to determine if permanent set had taken place in the stiffeners. See Table 2 for deflections at zero after relaxing from 25 lb. gage. Figure 5 shows method used to check deflection of stiffeners.

Pressure was again applied up to 30 lb. gage and held for deflection readings. See Table 3 for deflections at 30

Table 1—Deflections at 25 Lb.

Distance from Top, Ft.	Bulkhead *B* Stiffener Number 1	2	3	4	5
2 1/2	1/8	5/16	9/16	5/16	1/16
5	5/16	9/16	7/8	1/2	5/16
7 1/2	1/4	7/16	5/8	5/16	3/16
	Bulkhead *A* 5	4	3	2	1
2 1/2	1/8	5/16	3/16	1/4	3/8
5	5/16	3/8	1/4	9/16	3/8
7 1/2	1/8	5/16	1/4	3/8	5/16

NOTE: Stiffeners 1, bulkhead *B*, and 5, bulkhead *A*, are opposite.

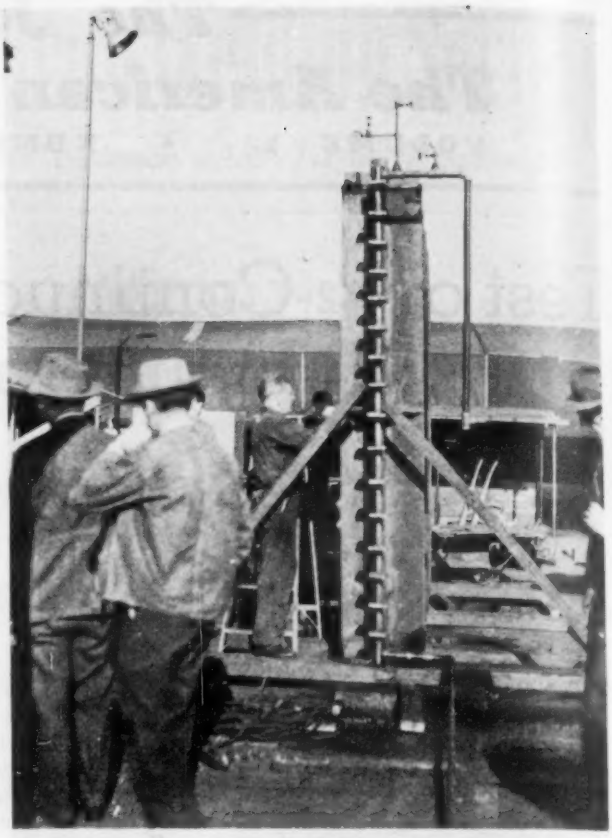


Fig. 3—End View of Bulkhead Assembly Under Pressure Test

Fig. 4—Assembly Under Pressure of 33 Psi. Gage. Note Approximately 2-In. Deflection of Center Stiffeners

Fig. 5—Checking Deflection of Stiffeners

Table 2—Deflectors at Zero Relaxed from 25 Lb.

Bulkhead *B*

Distance from Top, Ft.	Stiffener Number 1	2	3	4	5
2½	1/16	3/16	3/8	1/8	1/8
5	1/8	5/8	9/16	1/4	3/16
7½	1/8	5/16	5/8	3/16	1/8

Bulkhead *A*

	5	4	3	2	1
2½	0	1/16	0	1/8	1/8
5	0	1/16	0	1/4	3/16
7½	0	1/16	0	1/8	1/8

NOTE: Stiffeners 1, bulkhead *B*, and 5, bulkhead *A*, are opposite.

lb. At about 32 lb. pressure the stiffeners appeared to be deflecting and bowing out at a yield point stress as additional pumping did not raise the gage above 33 lb. The assembly was held at 33 lb. for deflection readings. See Table 4. With the gage still reading 33 lb., additional water was pumped until a leak occurred at the center of the top edge seal weld. Pressure was relaxed to zero, to close up the leak, but examination of the stiffener welds showed several stiffeners with the top and bottom end welds starting to shear lengthwise of the welds as recorded in Figs. 6 and 7.

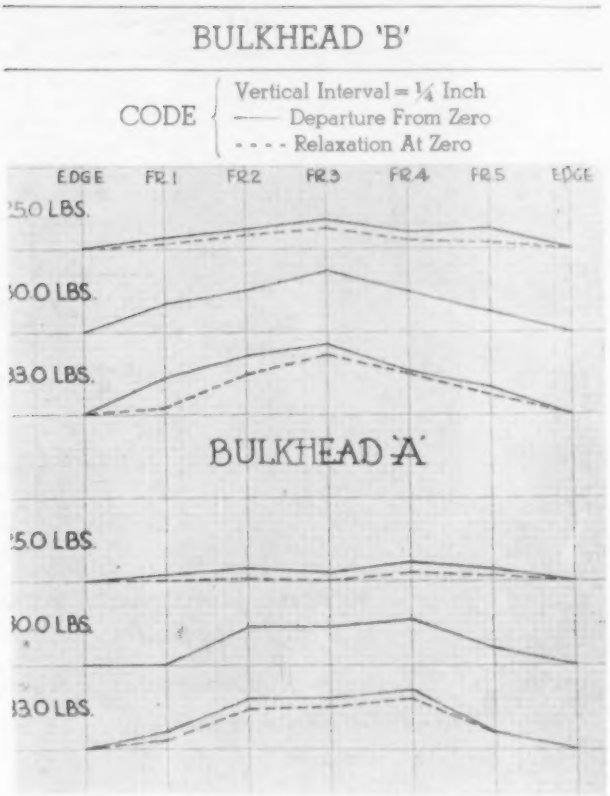


Fig. 6 (*a*)—Bulkhead *B*

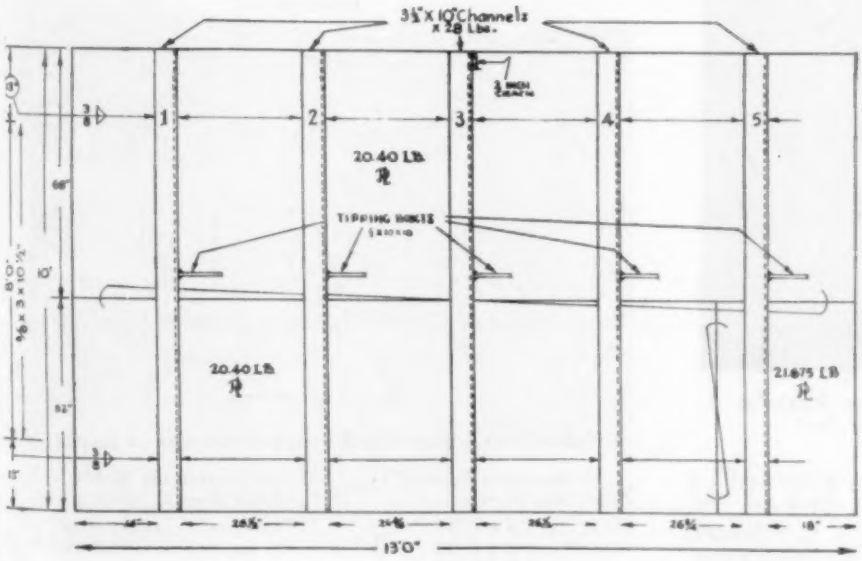
It was then decided that the assembly had started to fail by shearing the end welds of the stiffeners so the test of the intermittent welds was declared satisfactory as no failure of the intermittent welds occurred and the stiffeners did not buckle between the intermittent welds.

Table 5 shows deflection readings at zero pressure relaxed from 33 lb. and indicates a maximum permanent set of $1^{13}/_{16}$-in. bow in bulkhead *B* and $1^{1}/_{2}$-in. maximum permanent bow in stiffeners of bulkhead *A*.

Figure 8 shows one of the standard 3-in. increment-welded stiffeners on bulkhead *A* after test with a straight line string alongside to indicate the small amount of side deflection occurring, while Fig. 9 shows the same for bulkhead *B* with $^{1}/_{2}$-continuous welds.

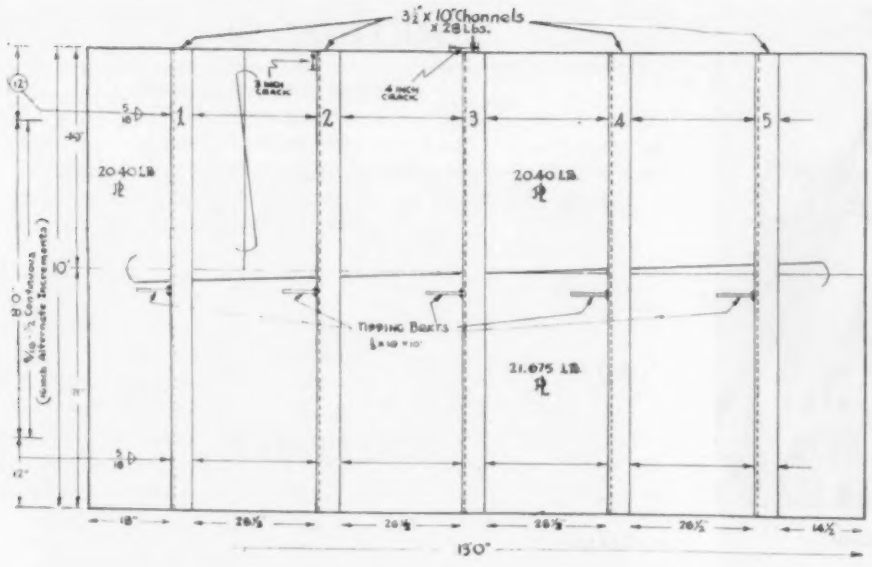
The two types of weld attachment, therefore, withstood a pressure equivalent to a test head of 75 ft. of water with failure occurring in the continuous-welded ends.

A table of equivalent average strengths of intermittent welds and $^{1}/_{2}$-continuous welds is shown in Table 6. These values are based on ultimate strengths of fillets in accordance with Navy standards and show that $^{1}/_{2}$-continuous welds are at least equal to the next larger size intermittent welds spaced 8 in. or more.



STANDARD 3×10½ ATTACHMENT.

Fig. 6—Bulkhead *A*



PROPOSED ½ CONTINUOUS ATTACHMENT.

Fig. 7—Bulkhead *B*

Part II

Part I of this report gives data pertaining to a pair of test bulkheads in which the stiffeners were placed on the outside of the assembly. In order to test the comparative weld strength of a similar pair of bulkheads, but with the stiffeners placed on the inside of the assembly, Part II of this test was conducted and results are given below.

Figure 10 shows the bulkhead assembly under test.

The two bulkheads used for the second pressure test were practically identical with those used for the first test except that the method of assembly necessarily had to be altered to provide room for the stiffener inside the assembly. Also, the stiffeners were not fastened together at the ends in the second test but

Table 3—Deflections at 30 Lb.

Bulkhead *B*

Distance from Top, Ft.	Stiffener Number 1	2	3	4	5
2½	5/16	11/16	1	11/16	3/8
5	13/16	1 1/4	1 13/16	1 3/16	5/8
7½	3/8	1	1 1/4	11/16	7/8

Bulkhead *A*

	5	4	3	2	1
2½	0	11/16	5/8	11/16	3/8
5		1 1/8	1 1/8	1 5/16	1/2
7½	1/4	13/16	13/16	7/8	3/8

NOTE: Stiffeners 1, bulkhead *B*, and 5, bulkhead *A*, are opposite.

Table 4—Deflections at 33 Lb.

Bulkhead *B*

Distance from Top, Ft.	Stiffener Number 1	2	3	4	5
2½	3/16	15/16	1 3/8	15/16	1/2
5	1 1/16	1 3/4	2 1/8	1 4/8	13/16
7½	1 1/8	1 3/8	1 5/8	1 1/16	9/16

Bulkhead *A*

	5	4	3	2	1
2½	5/16	15/16	13/16	1	3/8
5	1/2	1 1/2	1 1/2	1 3/4	7/16
7½	5/16	1 1/16	1 1/16	1 1/4	7/16

NOTE: Stiffeners 1, bulkhead *B*, and 5, bulkhead *A*, are opposite.

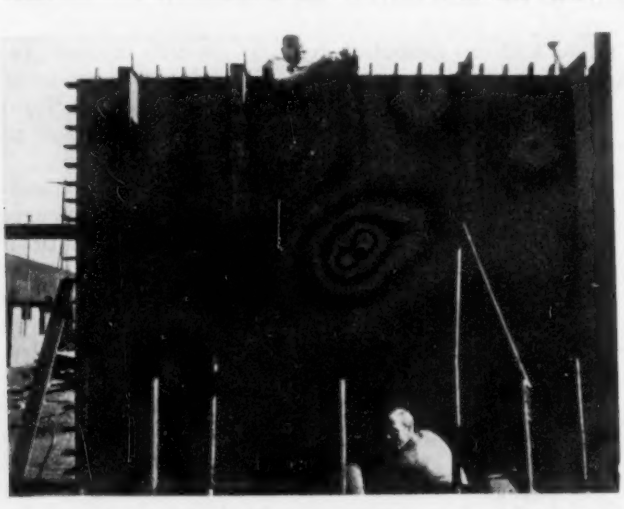


Fig. 8—Showing Straightness of Stiffeners on Bulkhead *A* After Applying Pressure Test of 33 Lb./In.²

Testing of the bulkhead assembly was witnessed for the American Bureau of Shipping by B. A. McLean, Pacific Coast Coordinating Surveyor, and C. J. L. Schoefer, Senior Surveyor at Calship; for the U. S. Maritime Commission by J. J. Muldoon; and for Calship, C. W. Ryan, Chief Engineer, Carl Rettig, Jr., Chief of Hull Design and M. H. MacKusick, Welding Engineer.

Table 5—Deflection at Zero, Relaxed from 33 Lb.

Bulkhead *B*

Distance from Top, Ft.	Stiffener Number 1	2	3	4	5
2½	3/16	11/16	3/4	3/4	5/16
5	3/16	1 3/16	1 13/16	1 1/4	9/16
7½	1/4	1	1 3/16	13/16	5/16

Bulkhead *A*

	5	4	3	2	1
2½	1/8	3/4	11/16	15/16	1/8
5	1/4	1 3/16	1 1/4	1 1/2	1/2
7½	1/8	15/16	15/16	1 1/16	3/8

NOTE: Stiffeners 1, bulkhead *B*, and 5, bulkhead *A*, are opposite.

Table 6—Comparative Average Strengths of Joints

Intermittent Welds, Fillet Size × Spacing, In.	½-Continuous Welds, Fillet Size × Spacing
1/4 x 3 x 7.94	3/16 In. x ½-continuous
5/16 x 3 x 7.46	1/4 In. x ½-continuous
3/8 x 3 x 6.96	5/16 In. x ½-continuous
7/16 x 3 x 6.72	3/8 In. x ½-continuous
1/2 x 3 x 6.65	7/16 In. x ½-continuous

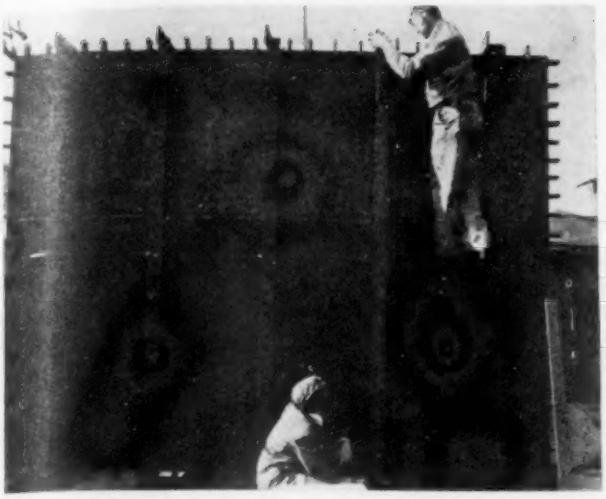


Fig. 9—Bulkhead *B* After Pressure Testing to 33 Lb.

Table 6A

Based on U. S. Navy Specifications as Follows:

Fillet Size, In.	Ultimate Strength per In. of 2 Fillets, Lb.
5/16	15,500
1/4	20,500
5/16	25,000
3/8	29,000
7/16	32,500
1/2	36,000

were welded to the plating in the same manner as shown in Figs. 6 and 7.

Pressure was applied to the assembly after taking zero pressure readings, and brought up to 23.5 lb. gage for deflection readings. See Tables 7 and 8 for deflection readings at zero, 23, 26½, 32, 38 and 42½ lb., and after relaxing from a breaking pressure of 48½ lb.

Fig. 11—Bulkhead *A* (3-In. Increment Welds) After Testing to 48½ Lb. Pressure. Note the Bowing and Distortion of the Stiffeners

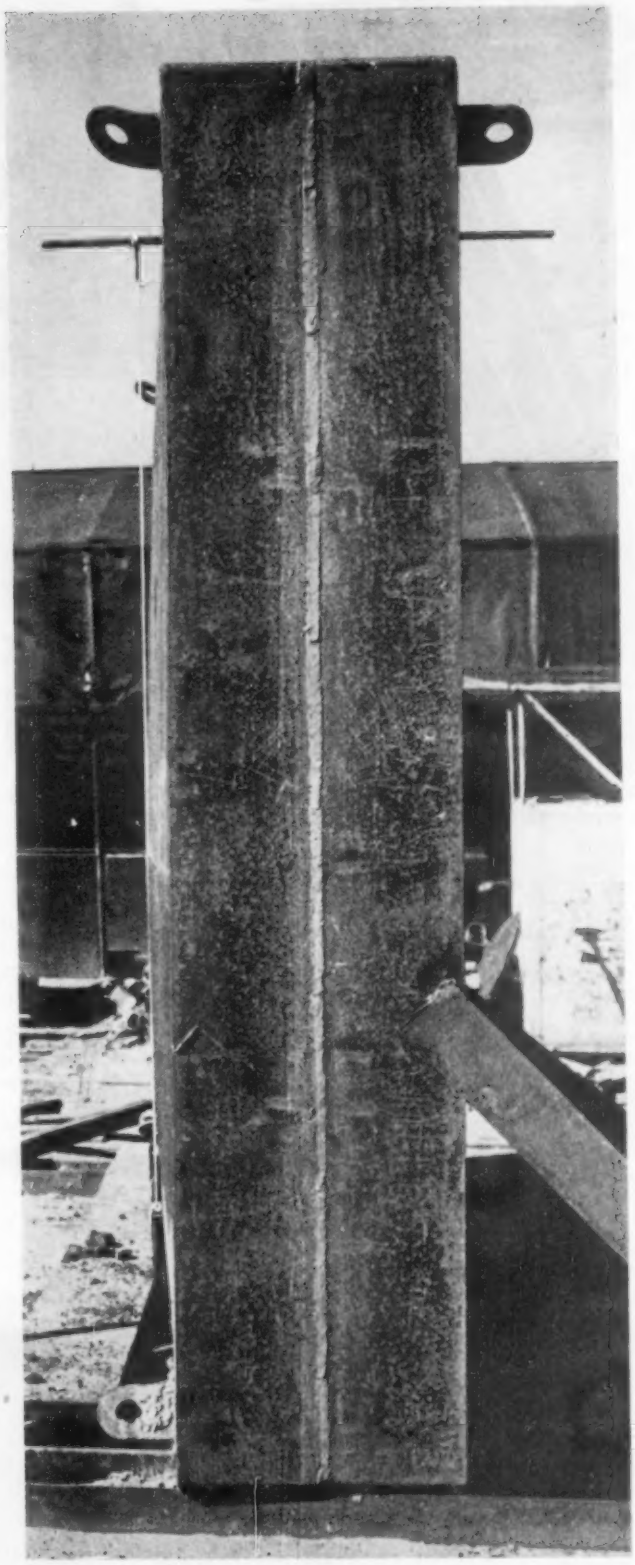


Fig. 10—Bulkhead Assembly with Stiffeners on the Inside, Under Test. Note the Deflection of the Plating Compared to the Cord Hung on the Left Side

Failure of the assembly occurred at 48½ lb. pressure, and occurred in the plating at the bottom end of the stiffeners. The pressure at the bottom of the assembly was actually about 5 lb. per sq. inch more than the gage readings due to the static head of water in the assembly which was approximately 11 ft. high to the gage connection from the base.

Fig. 12—Bulkhead *B* (Long Increment Welds). Note Bowing of Stiffeners Due to Pressure Test of 48½ Psi.

Table 7—Bulkhead A, 3-In. Increment Welds*

Pressure, Lb.	Edge	Fr. 1	Fr. 2	Fr. 3	Fr. 4	Fr. 5	Edge
23.0	0	3/16	10/16	7/16	7/16	4/16	−1/16
26.5	0	5/16	1 0/16	15/16	15/16	6/16	0
32.0	0	7/16	1 10/16	1 10/16	1 8/16	10/16	−1/16
38.0	0	12/16	2 12/16	2 7/16	2 4/16	14/16	−1/16
42.5	0	1 3/16	2 15/16	3 2/16	2 14/16	1 2/16	−1/16
Relaxed to zero from 48.5 lb.	−1/16	1 0/16	2 12/16	3 1/16	2 11/16	1 1/16	−1/16

*Readings given were taken at point approximately 5 ft. from top and represent deflection from zero.

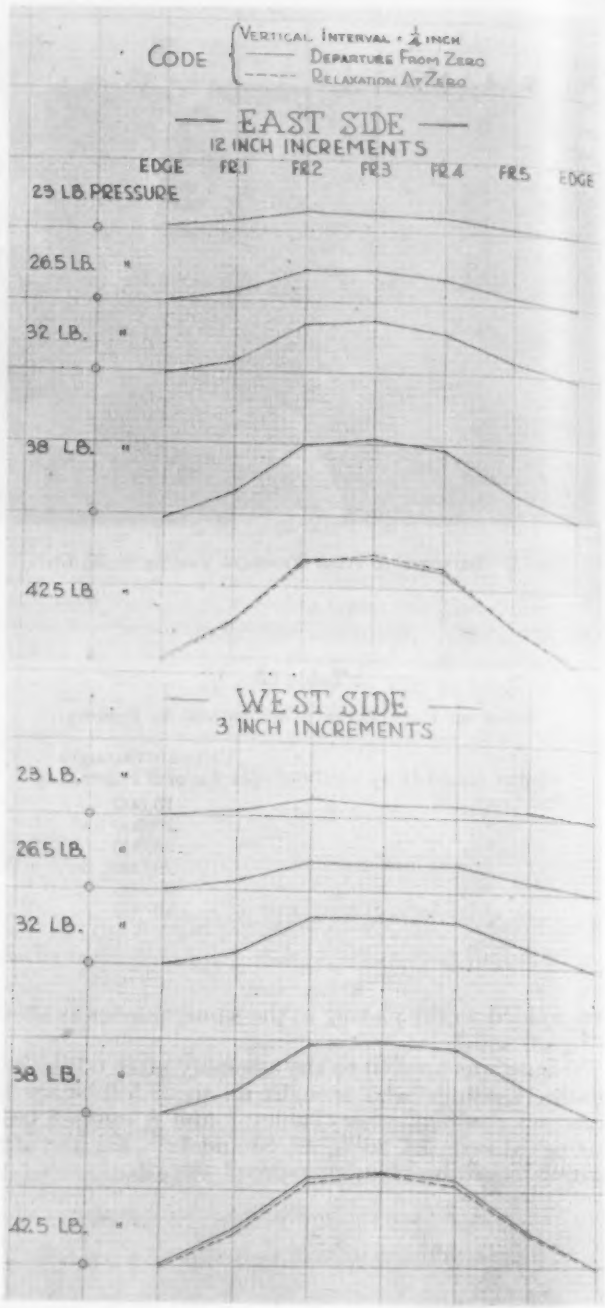


Fig. 15

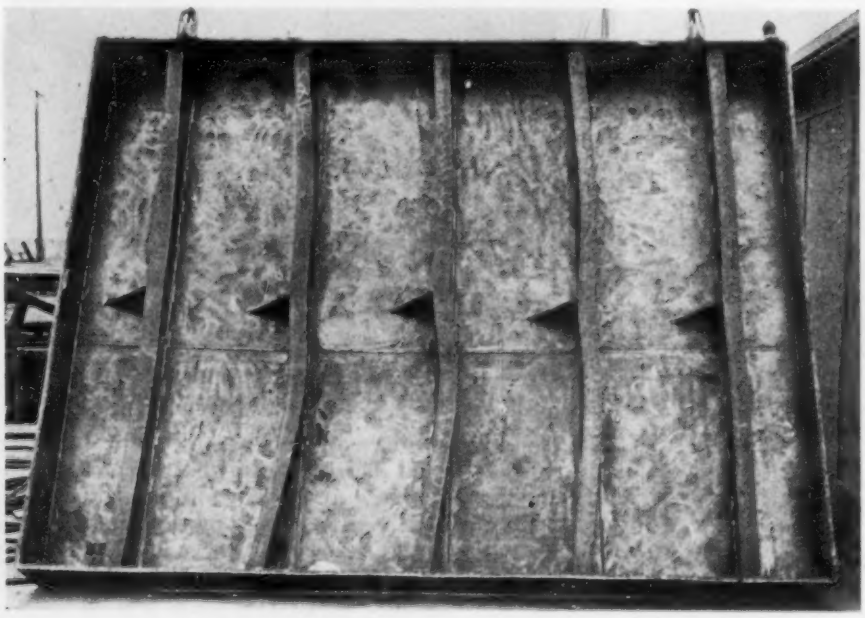


Fig. 13—Bulkhead A (3-In. Increment Welds) After Pressure Test to 48½ Lb.

Figures 11 and 12 show the two bulkheads after testing and are taken at an angle to show the bowing of the stiffeners and plating.

Figures 13 and 14 show a face view of the two bulkheads after pressure test and show the twisting distortion of the stiffeners.

No evidence of failure of the welds between stiffeners and plating occurred in either of the two bulkheads.

Fig. 14—Bulkhead *B* (Long Increment Welds) After Pressure Test to 48½ Lb. Note the Second Stiffener from the Right Torn Loose from the Tilting Bracket

One of the tilting brackets ripped loose on bulkhead *B* as can be seen in Fig. 13.

Figure 15 shows deflection values plotted for the two bulkheads at the different pressures up to the breaking point.

Summary of Tests

From the data obtained in the above tests, it is evident that long increment welds can be substituted for conventional 3-in. increment welds for the purpose of securing stiffeners to ships' plating. Long increment welds of equivalent strength will behave under pressure loading in a similar manner to 3-in. conventional welds.

Since the work reported in this paper was started, the Yard has obtained approval to substitute long increment welds for 3-in. increment welds providing the stiffener length is greater than 7 ft. and the substitution provides equivalent strength.

The original suggestion to substitute long increment welds for the conventional 3-in. increment welds was made by J. H. Moses, Welding Superintendent of Subassembly, in order to improve the efficiency of his department by eliminating the numerous starts and stops involved in the 3-in. increment design.

Table 8—Bulkhead B, Long Increment Welds*

Pressure, Lb.	Edge	Fr. 1	Fr. 2	Fr. 3	Fr. 4	Fr. 5	Edge
23.0	1/16	5/16	11/16	9/16	8/16	2/16	0
26.5	0	5/16	1 2/16	1 2/16	14/16	4/16	−1/16
32.0	−1/16	6/16	1 11/16	1 13/16	1 7/16	7/16	−2/16
38.0	−2/16	12/16	2 7/16	2 11/16	2 5/16	13/16	−1/16
42.5	0	1 4/16	3 7/16	3 8/16	3 1/16	1 2/16	−2/16
Relaxed to zero from 48.5 lb.	−1/16	1 4/16	3 6/16	3 10/16	3 2/16	1 3/16	−1/16

* Readings given were taken at point approximately 5 ft. from top and represent deflection from zero.

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Stresses in Fillet Welds with Eccentric Loads

By M. F. Spotts*

THE problem of stresses in welds is one which continually confronts the designer of joints carrying computed loads. There are many equations, based on as many initial assumptions, which are supposed to give the value of the stresses occurring in welds.

Despite this apparent lack of agreement as to the correct procedure to be followed there are at least two cases on record of tests of fillet welds in tension where the loads carried by the welds were in good agreement with the theoretical values as computed by basic equations of strength of materials.[1, 2]

The method of computing the stress in the articles referred to above will be briefly reviewed here, after which this same method will be extended to the case of fillet welds carrying moment loads. Use of this latter method will be illustrated by numerical examples.

Fillet Welds in Tension

Figure 1 (*a*) shows two bodies connected together by a fillet weld having equal legs, h and length, l. The tensile load of P pounds acts in a direction perpendicular to l. It is assumed that the plates are supported in such fashion that the weld is free from bending.

* Northwestern Technological Institute, Evanston, Illinois.

Figure 1 (*b*) shows a cross section taken through the throat AB of the weld and the stresses acting thereon. Let the force, parallel to P, which acts on each square inch of the inclined throat surface be called stress, S_t. Its magnitude is found by dividing P by the throat area hl cos 45° or 0.707 hl.

That is

$$S_t = \frac{P}{0.707hl} \tag{1}$$

Stress S_t can be divided into components S_n normal to the threat surface and shear S_{ny} parallel to the throat surface as shown in the figure. The normal or tensile component S_n is seen to be

$$S_n = S_t \cos 45° = \frac{P}{hl} \tag{2}$$

The shear stress S_{ny} is found by a similar equation.

$$S_{ny} = S_t \sin 45° = \frac{P}{hl} = S_n \tag{3}$$

From strength of materials the maximum or resultant tensile stress in the throat material due to the combined effects of the normal and shear stresses is given by the following equation.

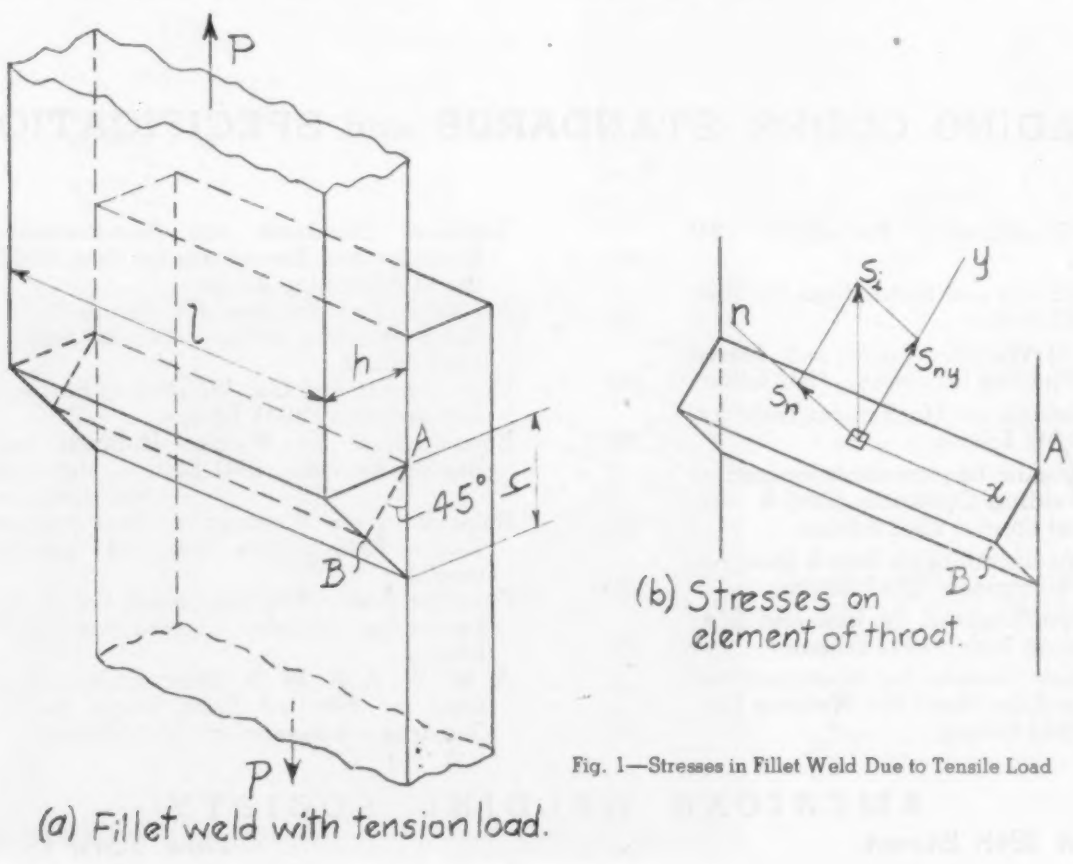


Fig. 1—Stresses in Fillet Weld Due to Tensile Load

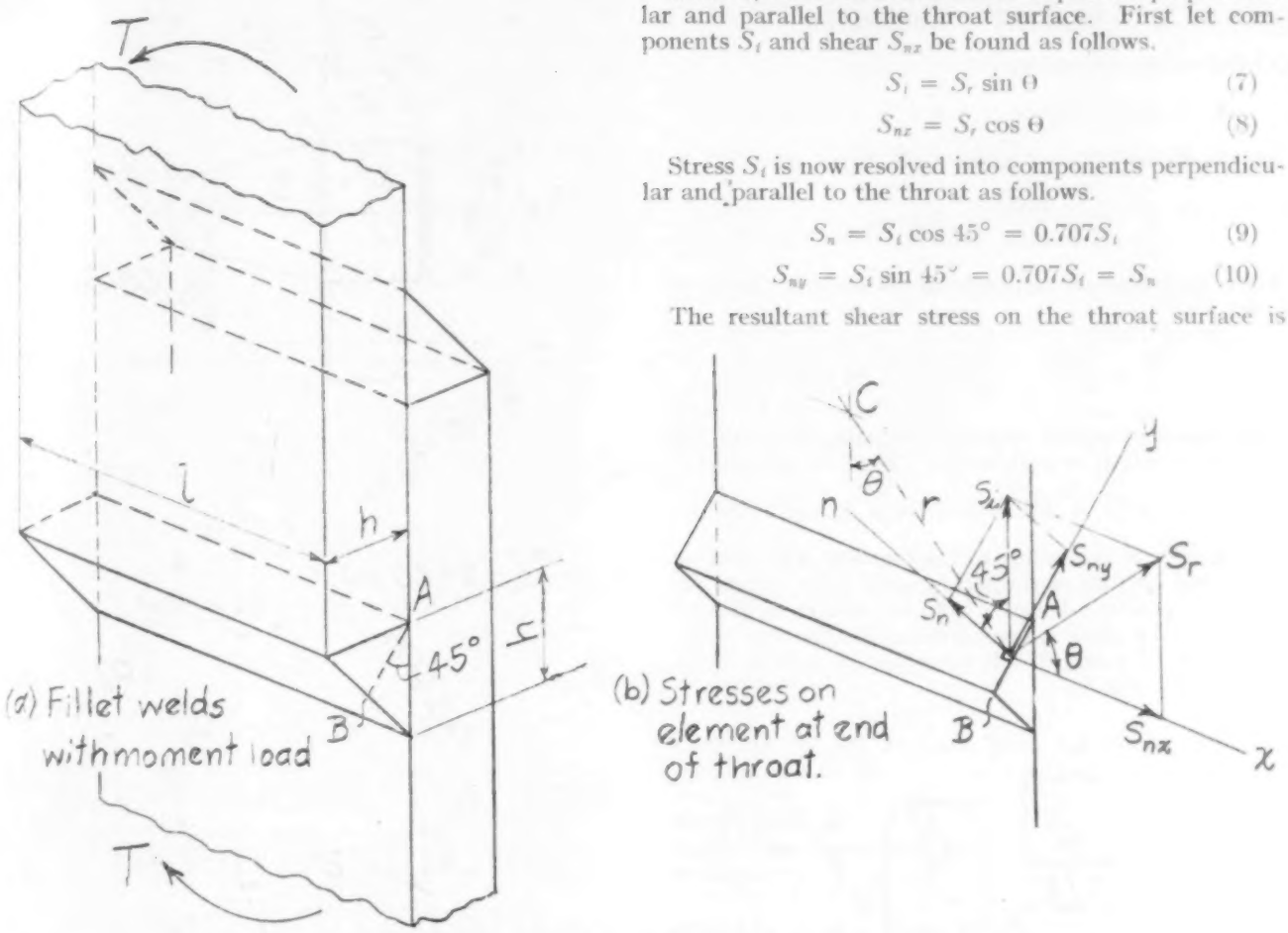


Fig. 2—Stresses on Fillet Welds Due to Moment Loads

$$S_{max.} = \frac{S_n}{2} + \sqrt{\left(\frac{S_n}{2}\right)^2 + S_s^2} \qquad (4)$$

Here S_s is the shear stress, or as indicated above S_{ny}, which is equal to S_n. Substitution gives

$$S_{max.} = \frac{S_n}{2} + \sqrt{\left(\frac{S_n}{2}\right)^2 + S_n^2} = 0.5S_n + \sqrt{1.25S_n}$$

$$= (0.5 + 1.118)S_n = 1.618\frac{P}{hl} \qquad (5)$$

As previously mentioned Equation 5 is in good agreement with tests results.

Fillet Welds with Moment Loads

Now let the two plates be joined by two fillet welds as shown by Fig. 2 (*a*), and let the loading consist of the two equal and opposite torques T.

Since the stress in the welds is due entirely to the moments T, it may be found by the well known equation

$$S_r = \frac{Tr}{J} \qquad (6)$$

Here S_r, as shown in Fig. 2 (*b*), is the stress in pounds per square inch on the inclined throat surface. It is directed at right angles to the radius r extending from the element to the center of gravity, C, of the welds. The polar moment of inertia J about C is computed in the usual fashion for the inclined throat surfaces.

Stress S_r must be resolved into components perpendicular and parallel to the throat surface. First let components S_t and shear S_{nx} be found as follows.

$$S_t = S_r \sin \theta \qquad (7)$$

$$S_{nx} = S_r \cos \theta \qquad (8)$$

Stress S_t is now resolved into components perpendicular and parallel to the throat as follows.

$$S_n = S_t \cos 45° = 0.707S_t \qquad (9)$$

$$S_{ny} = S_t \sin 45° = 0.707S_t = S_n \qquad (10)$$

The resultant shear stress on the throat surface is found by combining S_{nx} and S_{ny} as follows.

$$S_s = \sqrt{S_{nx}^2 + S_{ny}^2} = \sqrt{S_{nx}^2 + S_n^2} \qquad (11)$$

The resultant tensile stress for the throat material is found by substitution into Equation 4.

$$S_{max.} = \frac{S_n}{2} + \sqrt{\left(\frac{S_n}{2}\right)^2 + S_s^2}$$

$$= \frac{S_n}{2} + \sqrt{\left(\frac{S_n}{2}\right)^2 + S_{nx}^2 + S_n^2}$$

$$= 0.5S_n + \sqrt{1.25S_n^2 + S_{nx}^2} \qquad (12)$$

Combined Bending and Direct Stress

Fillet welds are frequently loaded by a combination of direct load and moments. The normal and shear stresses due to each load acting separately are first found. The various components in the direction of the axes x, y, and n are then added together algebraically, and finally the resultant tensile stress is found by the combined stress equation.

The process will be illustrated by the following numerical examples.

Numerical Example No. 1.

Figure 3 (*a*) shows a welded joint carrying an eccentric load. The welds can be considered as being affected by the two following loads (1) a centrally applied force of

6000 lb. (2) a torque equal to the product of the force by the distance from its line of action to the c.g. of the welds. That is

$$T = 6000 \times 7 = 42{,}000 \text{ in. lb.}$$

The total throat area is

$$A = 2 \times (0.707 \times 1/4) \times 6 = 2.12 \text{ sq. in.}$$

On the inclined throat surface, the direct stress is

$$S_t = \frac{6000}{2.12} = 2830 \text{ psi.}$$

For a long narrow rectangle about its own center of gravity

$$J_o = \frac{bl^3}{12} = \frac{0.707 \times 0.25 \times 6^3}{12} = 3.19 \text{ in.}^4$$

The transfer formula is used for getting J about the center of gravity C of both welds. Thus for the joint

$$J = 2(J_o + Ad^2) = 2(3.19 + 1.06 \times 2^2) = 14.87 \text{ in.}^4$$

The maximum stress due to the moment will occur at the top and bottom of the welds since these points are located the greatest distance from the center of gravity C. Thus if the plate is considered to be the free body, the stress S_r at point A will be as shown in Fig. 3 (*b*). Its magnitude will be

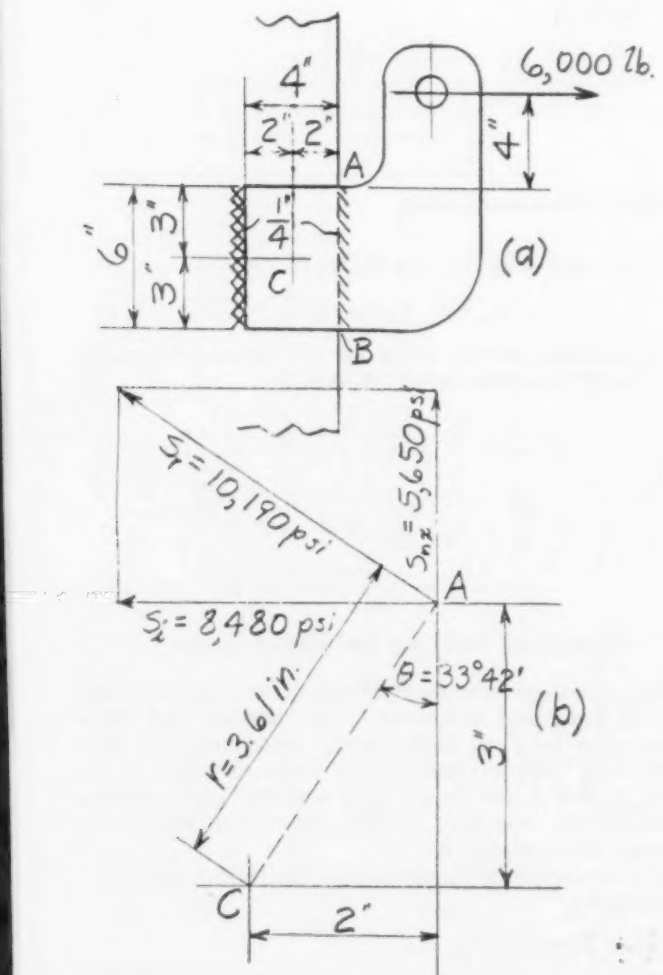


Fig. 3—Welded Joint of Example No. 1

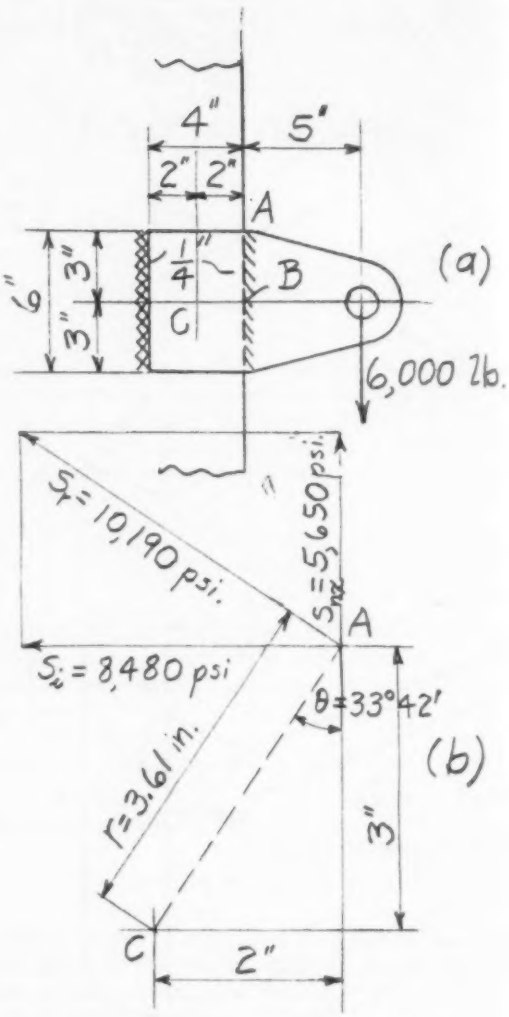


Fig. 4—Welded Joint of Example No. 2

$$S_r = \frac{Tr}{J} = \frac{42{,}000 \times 3.61}{14.87} = 10{,}190 \text{ psi.}$$

This stress has the components

$$S_t = 10{,}190 \cos \Theta = 8480 \text{ psi.}$$

$$S_{nx} = 10{,}190 \sin \Theta = 5650 \text{ psi.}$$

The total value of S_t due to direct and moment load is

$$S_t = 2830 + 8480 = 11{,}300 \text{ psi.}$$

This stress breaks into the components

$$S_n = 0.707\ S_t = 0.707 \times 11{,}300 = 7990 \text{ psi.}$$

$$S_{ny} = 0.707\ S_t = 0.707 \times 11{,}300 = 7990 \text{ psi.}$$

The maximum resultant tensile stress by Equation 12 becomes

$$S_{max.} = 0.5\ S_n + \sqrt{1.25\ S_n^2 + S_{nx}^2}$$
$$= 0.5 \times 7990 + \sqrt{1.25 \times 7990^2 + 5650^2}$$
$$= 4000 + 10{,}570 = 14{,}570 \text{ psi.}$$

The stress at point A is greater than at B since at this latter point stresses S_t caused by direct load and moment are directed oppositely. The resultant is the difference between them instead of the sum as at A.

Numerical Example No. 2.

A slightly different situation prevails for the joint shown in Fig. 4 (*a*). The dimensions are the same as in

Example 1, but the direction of the load has been changed. Here again the joint is subjected to a direct force of 6000 lb. and a torque of 42,000 in. lb.

The direct load, which in this case is parallel to the welds, will not be uniformly distributed over the throat surfaces. At the top and bottom of the welds the stress due to direct load will be zero, while at the midpoint B it will be three-halves the average valve. In other words the direct shear will be distributed in a manner similar to the transverse shear in a beam.

The stresses at point A will be due solely to the torque. As before

$$S_r = 10{,}190 \text{ psi.}$$
$$S_i = 8480 \text{ psi.}$$
$$S_{nz} = 5650 \text{ psi.}$$

Stress S_i breaks into the components

$$S_n = 0.707\ S_i = 0.707 \times 8480 = 6000 \text{ psi.}$$
$$S_{ny} = 0.707\ S_i = 0.707 \times 8480 = 6000 \text{ psi.}$$

The maximum resultant tensile stress by Equation 12 is

$$S_{max.} = 0.5\ S_n + \sqrt{1.25\ S_n^2 + S_{nz}^2}$$
$$= 0.5 \times 6000 + \sqrt{1.25 \times 6000^2 + 5650^2}$$
$$= 3000 + 8770 = 11{,}770 \text{ psi.}$$

At the midpoint B the direct stress is

$$S_{nz} = \frac{3}{2} \times \frac{P}{A} = \frac{3}{2} \times \frac{6000}{2.12} = 4240 \text{ psi.}$$

The stress at this point caused by the torque is found by Equation 6.

$$S_{nz} = \frac{Tr}{J} = \frac{42{,}000 \times 2}{14.87} = 5650 \text{ psi.}$$

The resultant stress in the material is a shear stress equal to the sum of the above two stresses.

$$(S_s)_{max.} = 4240 + 5650 = 9890 \text{ psi.}$$

From strength of materials the resultant tensile stress will have the same value.

It should be noted that Equation 12 is completely general and is unaffected by the number, size or location of the welds so long as the entire joint acts as a unit.

References

1. Jennings, C. H., *Trans. Am. Society of Mechanical Engineers* **59**, 462, (1937).
2. Jensen, C. D., JOURNAL OF THE AMERICAN WELDING SOCIETY, **13**, 17, (Feb. 1934).

Arc-Welded Tractor-Trailer Eliminates Loading Hazard

By Fred Reynolds

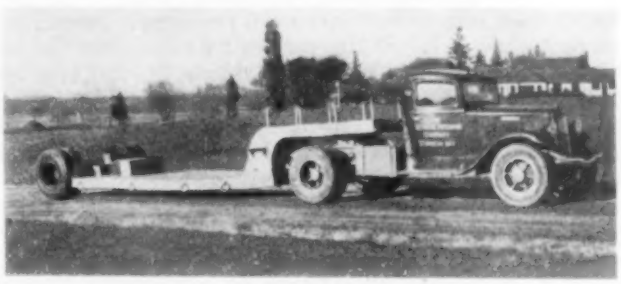
FOR several years, Reynolds Brothers of Sturgeon Bay, Wis., have hauled a large tractor with dozen attachments on a large semi-trailer flat rack whenever their work was to be carried on at a distance from their shop. While the tractor was not so heavy ($7\frac{1}{2}$ tons) it was mean and dangerous to load with planks and blocking. Last winter one of the drivers dumped the tractor off the trailer and it took a wrecking crew half a day to untangle the wreckage and two men one week to repair the damage to the tractor and truck.

Right then a decision was made by the Reynolds Brothers to look around for available materials to build a trailer suitable for their needs, and one that could be built in their own shop with arc welding. After dreaming a few nights and looking around during the day they located an old dump truck with good heavy frame which they bought for $30, and together with two heavy rear ends, two old motors and various thicknesses of plate, they started to build this 8 x 25-ft. over-all trailer in their own shop that measured only 20 x 30 ft. The underslung bed was to be 8 x 14 ft. with a ground clearance of 10 in.

All welding was positioned on a frame by revolving work similar to fish net reel. The frames were made tubular instead of just channel, and the four main beams 3 x 7-in. tube. Cross frames were $2\frac{1}{2}$ x 6-in. tubes alternating with $2\frac{1}{2}$ x 6-in. tees made from plate.

The gooseneck to get the rise to the fifth wheel was made of two arched tubes 8 x 4 in. x 8 ft. and was gusseted throughout to keep from buckling. Whenever strength was doubted, $\frac{7}{16}$-in. fish plates were added and concealed in tubes and arches. The various plates used were $\frac{1}{4}$, $\frac{3}{16}$, $\frac{5}{16}$ in. and in a few places $\frac{7}{16}$ in. Deck plates were made by spotting floor plate design on common smooth plates with $\frac{3}{16}$-in. rod.

Air booster brakes were built in complete. The fifth wheel pin is made standard size to fit any tractor wheel lock and was made on their lathe out of a 4-in. drill jaw and welded into frame of tractor with gussets.



Photograph and data courtesy The Hobart Brothers Co., Troy, Ohio

The trailer weighs complete 5945 lb. and was completed in three weeks with one welder and a helper. The approximate cost was $600. Built to haul 8 tons, it has since hauled 15 tons (two tractors loaded crosswise). Barrel deck for fuel oil is old pipe with chain railing; steps to barrel deck are welded on each side and emergency jacking shelf all welded to the gooseneck. Necessary loading equipment are two blocks of wood to raise front of tracks so trailer can crawl onto bed of body.

It formerly required two men at least two hours to load, haul five miles, unload and return, but now with the new trailer the same can be accomplished in one hour with only one man and with much more safety than before. "We don't even travel the tractor as short a distance as one mile now," says Mr. Reynolds, "it's easier to load and haul, and saves tractor wear."

Resistance Welding Equipment—Designed for Production

By Clyde F. Kaunitz*

MANY articles and papers have been published from time to time on the subject of resistance welding. These have dealt mostly with various welding problems and methods and applications of the process in all forms of production, but very little, if any, mention has been made of one of the prime elements in this process, namely, the welding machine itself.

This article is written with the intention of introducing and reviewing certain items which, in general, deal with many phases of the art, and further, to offer some knowledge of the fundamentals of the welding machine. It is known that resistance welding is a welding process wherein the heat is obtained from resistance to the flow of an electric current during which pressure is applied, thereby creating a joint between metals. This process is a direct result of the correct combinations of three functions, namely, pressure, heat and time.

Electronics are playing a major part in providing a more dependable and accurate means of controlling the time element, that is, the duration of the current flow required to produce a weld. By this means it is possible to obtain a time setting, in cycles, or milliseconds, of a definite value of dependable repetition. In conjunction with accurate electronic controls we can now avail ourselves of electrical apparatus to definitely correct voltage within a small percentage of exactness, providing a means of maintaining a fixed value of the welding machine power.

Electrical apparatus is available for use to maintain a steady supply voltage and is known as the voltage compensator. In cases where a 440-v. supply is used on the transformer primary many previous installations have shown that, due to fluctuations in this supply line, erratic current flow results. In many instances this fluctuation does go as high as 20%. Obviously, this is a very poor condition and for this reason voltage compensators have been developed. By the use of such a device, the primary voltage to a welding machine transformer can be maintained within plus or minus 2%.

Some types of welding operations require the work to be moved into the throat of the welder as the process is performed. A section of ferrous material would have an effect of decreasing the output of a resistance welding machine and actually, as this mass increases within the throat, the welding current decreases. Electrical apparatus, known as the current compensator, is used to automatically maintain a constant welding current, correcting this condition.

The heart of any resistance welding machine is its transformer. During the many years of welding machine development and advancement, the transformer, which delivers the welding "heat," or amperes, has been a great source of study.

The general function of this transformer is now thoroughly understood by electrical engineers to a point where the designing of a transformer is no longer a mystery. Considerable progress has been made by the various manufacturers of the material so that today we can avail ourselves of primary copper, secondary copper, either cast or rolled, and core iron, of dependable specifications. Insulating materials, in all forms, are also available to complete the high quality specifications.

From experience, our electrical engineers have learned how to design and build welding transformers to meet the many diversified requirements of industry. For a known duty cycle the current density of the primary and secondary are established as well as the core iron magnetic flow proportions. Transformer secondary outputs are, therefore, calculated to suit the current requirements of a weld problem and are designed to comply with the characteristics of the welding machine secondary proportions.

Such general advancement has been made in transformer development that we are practically at the point where a welding machine transformer is worthy of a life guarantee.

The secondary voltage range provided by the transformer is used to further advantage when controlled by an electronic control with phase shift. By use of this unit a further heat regulation is obtained with infinite settings so that from 20 to 100% of full heat can be selected.

Having previously covered the means of obtaining welding heat and time, we will discuss the important function of welding force, or pressure.

We have pointed out we are able to obtain dependable current flow of a consistent value, so to coordinate the other function, we must have a pressure means of equal performance.

The means for obtaining welding pressure are many, beginning with manual, either hand or foot operation; next, mechanical through a pressure spring or air as an intermediate presssure medium; and also by means of direct air or hydraulic actuation. In some cases, weights have also been applied as a pressure means.

All of these methods have been applied and developed with a varied degree of success. On the various applications of resistance welding, the foregoing methods have been filtered out until only those which tend to produce values of dependable consistency are used.

But, regardless of the pressure medium, its application when built into the welding machine is of utmost importance. In the case of spot welders and seam welders and flash-butt welders, it is most often necessary that the application of the pressure to the weld area itself is not directly in line with the pressure medium. In many cases an offset in the mechanical structure is necessary, requiring considerable care and thought in the design to prevent deflection due to this condition.

By correctly proportioning the slide, or reciprocating unit, to which one electrode is attached, this can be eliminated. The bearing guides, or supports, must be brought as closely to the point of weld as possible, and further, this bearing should be of ample length to be of good design. After obtaining the proper design with respect to eliminating deflection, the next most important items are friction and inertia.

The moving secondary member, which feeds the current and supports the moving electrode, must be of sufficient section, cooled or otherwise, for conducting the required welding current at the proper duty cycle, without causing overheating. Obviously, this should be of minimum weight, and of proper conducting material. This member attaches to the moving ram of a press welder, or seam welder.

Experience has proved that, although weight has been reduced to a minimum by virtue of good design with respect to electrical and mechanical requirements, the item of friction will have a very detrimental effect on welding machine performance. As a means of reducing this to a minimum, antifriction designs have been

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adopted and proved to be highly superior to any other type. By mounting the moving members on ball or roller bearings, with hardened and ground guides, we are able to produce an actuating member having a minimum of friction for precision operation.

In conjunction with the above, friction must be further minimized in the unit which provides the operating pressure to the reciprocating ram. When direct operation is obtained from an air cylinder, the conventional type of cup, or ring packing, introduces excessive friction and presents a problem. To overcome this some manufacturers have incorporated a molded rubber coupling unit between the pressure medium and reciprocating member. In some cases this is a pneumatic cushion with a molded rubber enclosure, thus providing an ideal frictionless unit.

By the incorporation of an antifriction design guide unit, with antifriction pressure means, we are able to obtain a unit which can, without question, provide welding pressures of a consistently dependable value. In other words, the pressure means of a welding machine when set at a given value will reproduce this value repeatedly just as consistently as the electronic control which controls the welding current.

Having touched upon the major functions which provide for the best welding results, we should consider the welding machine as a complete unit.

To begin with, the ideal welding machine will be a self-contained unit. The machine frame structure should provide a complete enclosure, readily accessible for all of the composite parts of the complete apparatus. In addition to housing the transformer, etc., the electrical control unit, timing unit, sequence control, circuit breaker, etc., should all be mounted and permanently connected as one unit.

Remote attachments to any part of the equipment, together with all necessary dials and gages and meters should be mounted on a panel, visible and accessible to the operator. This panel would include a pointer stop ammeter, the timing adjustments for sequence and weld time, the heat regulation control, the weld pressure adjustment, a calibrated weld pressure dial and any other electrical controls of the equipment. With such an arrangement the operator at all times can observe the functions and settings of the machine.

In considering the application of resistance welding in production, experience has shown that many production parts can be welded after the subject parts are fully machined. This practice can only be successfully applied if the welding machine itself is suitable for this type of operation. Accuracy, therefore, becomes a requisite in the welding machine proper. All of the necessary adjustments of the machine's components must be available with the ease and accuracy afforded in our most modern machine tools, such as milling machines and boring mills. Micrometer adjustments in slides, of close tolerances, will be provided.

Combined with accuracy, rigidity of the components involved is also extremely important to minimize deflection. In certain welding applications, the welding fixtures demand that absolute parallel platen surfaces be provided.

The welding machine of tomorrow will be designed for greater longevity in peak production.

Through the advancement made in copper base alloys we can now quite definitely select the correct combinations of alloys for bearings, and the proper material for conductors, in addition to having the correct selection of material for all welding electrodes and dies. To further insure dependable performance of the welding machine with respect to the secondary conducting members, the practice of silver plating all secondary joint connections is in use. This when applied to well-fitted surfaces prevents corrosion and provides a better area through which secondary current is to pass.

Production equipment, such as reviewed here, must be designed and built with careful consideration of the maintenance problems. To begin with, accessibility is very important and to provide for this machine enclosures are built with large doors which allow access to the innermost parts of the machine.

The welding transformer and all tap regulators must be enclosed so dirt and flash cannot cause failures. All wiring should have terminal connections brazed or permanently attached so they cannot become a source of trouble. All secondary connections must be securely attached by use of a sufficient quantity of large bolts. These joints must be so fastened that they cannot become loosened during operation of equipment. Considerable overheating of conductors and loss of efficiency will result unless the above items are cared for.

The mechanical parts of a machine drive should be so arranged as to permit maintenance with least amount of time. Motors and valves, which require attention, should be placed in accessible areas. If possible, this apparatus would be best located in an area well off the floor, thus making them more accessible and readily serviced.

In the case of hydraulic and air-operated equipment, the material used for connections must be well installed. Tubing should be seamless tubing and attached with dependable fittings. Designing these circuits requires care because the repeated cycle of machine operation will cause annoying leaks to occur if lines are too long and improperly supported. Wherever hose is used on any system, an oil-resistant material is best whether it be used for oil or air lines.

Care must be taken in maintaining an air system on an air-operated circuit. The air-line lubricator must be periodically filled or trouble can occur because of lack of lubrication in the various parts. The air must be clean and, where a machine is provided with an individual strainer, occasional inspection and cleaning are required.

Maintenance of electrical apparatus is rapidly becoming easier. The simplification of circuits and the general elementary knowledge of the required functions are together in helping this situation. Proper diagrams, accompanied with detailed instructions, have been of great assistance to the average maintenance operator.

The many large production plants throughout the country have been aware of the maintenance problem. Recognition of the nature of the equipment involved has brought about the training of employees in this respect. This, with the able cooperation of welding-machine manufacturers, all helps to provide the best performance of the welding equipment.

In summing up, it is very obvious that, because of the broader acceptance of resistance welding day by day, the following is worthy of consideration, and that is—that resistance-welded products must rely on dependable equipment and that, although considerable thought is given to the control and the application of the process, the welding machine itself plays a most important part.

Metallic Arc-Welding Electrodes*

Part V—Class E6013 Electrodes

By Harold Lawrence†

THIS is the fifth part in the current series that deals with all-position mild steel electrodes in the E60xx group. To get this picture clearly, let's look at these previous articles a minute.

Two parts were devoted to electrodes that produce flat fillets and that were distinguishable by the digging arc possessed by each.

Of these electrodes, the E6010 is designed for direct current with reverse polarity only, whereas the E6011 electrode covers the same field with alternating current (although it can be used with direct current as well).

This article and the one immediately preceding it discuss the electrodes that produce a convex fillet and that are identified by a "cold" deposit that sets quickly. Originally the E6012 electrode was useful on direct current with straight polarity alone, although improved coatings and better alternating-current welders have changed this picture. To meet the need for an alternating-current electrode like the E6012, the E6013 type was introduced.

In the period from 1936 to 1940 alternating-current welding experienced an awakening of public interest. Up to that time there were many champions of alternating-current welding but the real acceptance of the process was yet to come. As usual there was a noticeable lag between development and application that happens every time something new is advanced.

One of the handicaps faced by alternating-current equipment makers was a strong feeling in the field that such units were extremely dangerous. Unfortunately a few serious accidents across the country served to confirm this suspicion until the real facts became available. However the sale of alternating-current transformers was slow until two steps were taken to combat the "danger" theory. One of these was to introduce relays in the secondary circuit to prevent the shock of the full open-circuit voltage from reaching the welding should the operator become careless. These relays dropped out when a metal to metal short existed as when the welder touched the end of the electrode to his work. In general, though, these relays and other similar devices have proved to be a nuisance to the user and with reasonable precaution they may be ignored.

The second way in which the danger of high open-circuit voltage was eliminated was in the construction of transformers that possessed inherently lower open-circuit characteristics. Also this method was considerably cheaper. Thus the several makers of small transformers that have been called "cracker boxes" chose the latter course. But the electrodes that were available did not perform very well. If a suitable electrode could be developed there would be a limitless opportunity for the expansion of welding through the widespread use of "cracker box" transformers.

As has been the custom with the welding industry, a new electrode appeared and the popularity of small alternating-current transformers followed the predicted course. Instead of requiring from 80 to 100 v. open circuit, the E6013 electrode was useful with an open-circuit voltage no greater than 40 v. This beneficial result was accomplished through a generous use of arc stabilizing chemicals. A soft, steady arc with shallow penetration accompanied the low open-circuit welding properties and the freedom from spatter was quite good.

Had the E6013 electrode made no further contribution than this, it would have been a most worth-while addition to the welding industry. But outstanding qualities in the welding of thin sections, over and above the excellent characteristics of the E6012 type, extended the use of E6013 electrodes into the sheet metal field where it worked well with alternating current or direct current and, finally, made possible many arc-welding applications in the aircraft plants where thin-walled tubing had necessitated gas welding as the only possible process for the purpose.

One manufacturer claims the following eight advantages of his E6013 electrode:

An alternating-current arc that is easy to strike and maintain.
Steady, uniform metal transfer.
Low spatter loss.
Easy slag removal.
Smooth, closely rippled welds.
Minimum "burn-through" on thin sections.
Easy to handle on vertical and overhead positions.
Freedom from slag interference when welding vertically down.

Let's examine these several points to see just what they mean in terms of the general group of E6013 electrodes as well as how these factors compare with similar items in the electrode groups discussed.

Of course the E6013 electrodes *do* have an arc that is easy to strike and maintain with alternating current. This is equally true no matter what the open-circuit voltage, that is, a good E6013 electrode will operate well with either low or high open-circuit voltage transformers. Furthermore, the coating ionizes so readily that the arc is started more easily with this electrode group than with any other. To further assist in ease of striking, some manufacturers attempt to have their coating reach all the way to the starting end of the electrode instead of leaving some bare wire at the end as is done with the other types.

A steady, uniform metal transfer will be found with some makes while other brands have a definitely globular transfer. Welding engineers are prone to recognize two distinct types of metal transfer frequently analyzed as "fine spray" and "globular" transfer. Either extreme

* A series of articles reprinted from the magazine *Steel*, Cleveland, Ohio.
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as well as almost any point between may be found with the available E6013 electrodes. Of course the fine spray is preferred as manipulation is easier with this kind of transfer. The arc has a soft sound and operator fatigue is slight when good metal transfer conditions obtain.

Although the E6013 electrodes are noted for low spatter loss, this matter, too, is subjected to very noticeable differences among the many brands on the market. It is true that the degree of spatter is frequently low but often not as low as that observed with the better E6012 electrodes. Both these convex fillet groups demonstrate low spatter characteristics. Because the E6013 electrodes usually have a heavier coating than the E6012 grade, somewhat more spatter may be anticipated. But if either group, in the particular brand being employed displays considerable spatter, there is something wrong either with the welding technique or with the electrode.

A claim for easy slag removal is readily substantiated. Perhaps this, too, is a function that may be explained because of a heavier coating. In any case, slag may be cleaned from E6013 welds with decidedly less work than is needed to do the same job with E6012 deposits. With flat beads, especially, the cold slag often displays a tendency to curl away from the weld without any prodding from a chipping hammer.

While on the subject of slag it may be well to point out that some brands do not show full slag coverage when used for a flat butt weld on light steel where no joint preparation is required. This lack of complete coverage often leads to a rougher bead than would be found if slag performance were better. However, all brands cover well in fillet or lap welding so that this point may not be too serious when the over-all situation is considered.

"Beauty" Advertises Craftmanship

Smooth, closely rippled welds are the rule when E6013 electrodes are used by able welders. Most sheet metal fabricators who have become familiar with the work possible with E6013 electrodes have gotten away from any prior inclinations toward grinding their welds before painting. The beautiful (and in this case "beautiful" becomes an apt engineering term) deposits show through the paint and act as an advertisement for outstanding welding craftsmanship.

Minimum "burn-through" on thin sections was considered in connection with the description of E6012 electrodes presented in the preceding article. For without question the general-purpose electrode did wonders with sheet metal welding. But the even more pronounced arc stability found with E6013 electrodes has refined an already good combination of electrode and work to an even better one.

In case the reader is from Missouri, all he has to do is give a welder a handful of good E6012 electrodes and a second handful of good E6013 electrodes. Now turn the welder loose on the thinnest section to be welded. When he finishes the two bundles of electrodes, let him choose either type for the balance of the work.

This same remarkable property of arc stability promotes outstanding welding characteristics in the vertical and overhead positions. Because of a slightly thicker coating, the E6013 deposits are less convex than the E6012 beads. A closely spaced ripple may be established for the same reason. All in all, with the lone exception of inferior ductility, the E6013 may be the best of the all-position electrodes.

Freedom from slag interference is the last of the eight points, not general freedom from slag interference as this is a common state of affairs but rather freedom from slag troubles when welding vertically down. Fast, neat welds of amazingly good appearance in quite thin gages result from this particular property of the slag. Lap welds in thin stock are made with the accuracy more often to be found on a drafting board.

Coating ingredients are largely the same as those used with E6012 electrodes. Some cellulose is used to provide a certain amount of gas shielding. Whereas about 5% of the coating may be cellulose in E6013 formulas, some 25% of the E6010 and E6011 coatings are compounded of cellulose. Rutile is the largest single ingredient used in this type of coating where it serves its customary dual role of slag former and arc stabilizer. Silicates, both aluminum and magnesium, are used for auxiliary slag formers while some calcium carbonate may be included as a slagging ingredient with some arc stabilizing qualities.

Completes Recipe for E6013

As usual ferromanganese is provided as a deoxidizer and to form a more friable, or glass-like, slag. Of course ferromanganese serves a further function by restoring manganese to the weld deposit. Add alkali arc stabilizers to bring about the alternating-current characteristics that are sought and bind the materials together and to the core with sodium silicate and the recipe for E6013 electrode coatings is complete.

This electrode group deposits a typical low-carbon steel weld metal such as is reported in Table 15. Once again a considerable spread exists in several elements.

Table 15—Deposit Analyses Produced by E6013 Electrodes

	C	Mn	P	S	Si	Cu	Mo	Ni
Min., %	0.07	0.30	..	..	0.05	..	...	...
Max., %	0.15	0.60	0.04	0.04	0.40	0.12	0.025	0.025

Table 16 gives the physical properties of the deposited weld metal. Not much change will be observed between these values and the ones previously given for E6012 electrodes. Both electrode groups deposit "cold" metal with some resultant porosity and with a tendency toward lower ductility values as measured by the elongation in 2 in. and the reduction of area. But for most applications it will be found that the ductility is ample.

Table 16—Physical Properties of Deposits Made with E6013 Electrodes

Property	Stress-Relieved	Nonstress-Relieved
Yield point, psi.	47–58,000	52–64,000
Ultimate strength, psi.	60–72,000	62–75,000
Elongation, % in 2 in.	22–29	17–25
Reduction of area, %	40–60	30–50
Izod impact resistance, ft.-lb.	27–50	
Brinell hardness	140–160	
Specific gravity	7.84–7.86	

Ranges for current and voltage are listed in Table 17 which does not show any values for electrode sizes beyond 1/4 in. It is known that at least the 5/16 in. diameter is

made but there is little use for the larger sizes. Some brands in the E6013 classification permit an extreme range in current. Because of the inherent arc stability built into these electrodes, they will weld with the lowest imaginable currents. On the high side, though, many brands exhibit a weakness. As a class the E6013 electrodes will not permit the high extremes of current that are possible with the E6012 electrodes.

Table 17—Current and Voltage Ranges for E6013 Electrode Applications

Size of Electrode, In.	Recommended Amperes	Recommended Volts
5/32	20–90	17–25
1/8	45–140	18–25
5/32	75–200	18–28
3/16	100–250	19–32
7/32	160–290	25–35
1/4	170–385	25–36

Lower voltage limits give a clue to the "cold" nature of the deposit. Any electrode that carries a recommended voltage below 20 v. is readily identified as a cold electrode. However, with alternating current a long arc can be sustained allowing shallow penetration as well as excellent control over the degree of penetration. This fortunate team of circumstances contributes to an already good set of light-gage welding properties.

There are not many approvals reported for the E6013 electrode group. Only three are shown in the following listing:

American Bureau of Shipping HlG, BlG, G, ElG.
City of Pittsburgh Building Code.
Hartford Steam Boiler Inspection and Insurance Company.

It should be remembered that not all of the 22 electrode type produced in this classification bear all of the approvals listed above. Individual approvals always depend upon the definite properties of any single brand. Approvals generally are sought by electrode manufacturers and are listed by them whenever their product becomes approved.

Reasons Approval Is Obviated

The short list of approvals for E6013 electrodes is understandable. Most often they are used in light-gage welding where brand approvals are of little importance. Or they are used in the aircraft industry where special qualification tests on the actual work being performed obviate any need for specific brand approval.

Although the aircraft industry began its welding on light tubular assemblies with E6012 electrodes, it was not long before the trend to E6013 electrodes became noticeable. The greatly improved arc stability of the latter type provided an explanation for this migration in demand.

Aircraft welding demands the utmost in quality. Often very thin sections are welded to comparatively heavy sections. Small direct-current generators provide most of the welding current. And under the conditions that exist in airplane manufacture, the E6013 electrode has done the best job.

A most interesting and complete discussion of the "Utility Characteristics of Aircraft Arc-Welding Electrodes" by C. B. Voldrich and R. D. Williams of Battelle Memorial Institute appeared in the *Welding Research Supplement* of THE WELDING JOURNAL for November 1942. The Table 12 on page 553-s of this article shows that for aircraft work in light-gage assemblies the following rating of E60xx electrodes might be used: first, E6013; second, E6012; third, E6010. Of course no true E6011 electrodes were reported but they would fall between second and third place in the preceding listing.

In the field of sheet metal work, the following applications lend themselves nicely to the E6013 electrode: fabrication and repair of auto fenders and bodies, ducts for heating and air conditioning, guards for moving machinery and gears, metal furniture, steel rowboats and other light craft, hot air furnaces, thin-walled storage tanks, thin structural units and window sash, ornamental iron work and so on.

E6012 electrodes are almost unaffected by storage; of course, the coating reaches an equilibrium with the moisture in the surrounding air but this has no harmful effect on the welding. On the other hand, E6013 electrodes do absorb moisture. This property, like all others found in electrode coatings, differs among the many brands. Warming the electrodes at a low temperature of approximately 150 to 200° F. for an hour or two should eliminate the major portion of any objectionable moisture that has been absorbed by the electrode.

Basically the E6013 electrode is a general-purpose or poor fit-up electrode quite like the E6012 type. However, it possesses a decidedly greater arc stability than the former. This feature enables E6013 electrodes to be used with "cracker box" transformers while resulting in extremely smooth performance with the larger transformers having higher open-circuit voltages. For the utmost refinement in the arc welding of thin steel sections, the E6013 electrode has no peer.

Part VI—Class E6020 and E6030 Electrodes

A COMMON theme carried through the preceding articles in this series was continued reference to all-position electrodes. Four separate parts were presented because each group of electrodes possessed distinctive characteristics with which users of the welding process should become acquainted.

Sometimes an effort was made to give clues to permit the user to separate one type from another even when the manufacturers tended to suggest all-inclusive properties embracing several groups with but one electrode. Now, however, when E6020 and E6030 electrodes are being considered, no effort at separation will be attempted.

Like Peas from One Pod

Why are the E6020 and E6030 electrodes treated as though they were a single type? Simply because the outstanding experts in the welding field cannot distin-

guish one from the other. Nor is this state of affairs surprising when one remembers that the two groups have identical physical properties. But the same statement may be made of the E6010 and the E6011 electrodes; or for that matter of the E6012 and E6013 electrodes. Still these groups are separable because the E6010 and E6012 electrodes were developed as direct-current electrodes while the E6011 and E6013 types were intended for alternating current. These are the distinguishing characteristics.

So far so good, except for some explanation as to why there are provisions for two groups when the facts indicate that one group would serve. Originally electrodes were introduced for down-hand or flat-position welding. On heavy weldments such electrodes were without equal. Then the welding fabricators felt a need for a similar electrode that would permit the making of horizontal fillets. In this application the E6030 electrodes had definite limitations. A "colder" electrode with better slag properties was needed. And enterprising electrode producers were not long in finding a product capable of doing this job. Thus the E6020 electrode came into being.

Summing up now we have E6020 electrodes suitable for horizontal fillets and flat-position welds while there are E6030 electrodes for welding in the flat position only. Most E6020 electrodes incorporate the features of the early E6030 electrodes so it is natural for many manufacturers to state that their electrodes meet the specifications for either E6020 or E6030 groups. Since both types work well with direct current (straight or reverse polarity, with the former preferred for speed) as well as with alternating current, there is no hallmark of distinction between them.

Why Called "Hot" Rods

Seven of the 20 manufacturers of this type of rod consider the E6020-E6030 electrodes interchangeable. These electrodes are often called "hot" rods. This nickname springs from their ability to perform well at higher currents than can be used with any other electrode type in the E60xx bracket. Naturally operation at high currents means excellent rates of deposit as measured by the pounds of metal laid down per welder per day.

It is a safe generalization to say that any place where "hot" rods can be used, their choice ought to be automatic because the best, strongest, soundest, smoothest weld is made with such rods. To be sure they must be applied in the flat position or in the horizontal fillet position. Another restriction indicates that plate thicknesses of $^3/_8$ in. or more are required to absorb the terrific amount of heat released by the molten steel and slag.

But where positioning is possible and where plate thickness is ample, E6020-E6030 electrodes are a MUST!

The modern pressure vessel industry has been built upon the flat-position electrode. Wall thicknesses greater than 4 in. are now welded layer by layer with E6020-E6030 electrodes. Then the X-ray is introduced to examine the seam. Picture after picture shows an absolute freedom from defects until to relieve their boredom inspectors begin to quibble about nonsensical trivialities. Where welding technique is an established routine, the foregoing statement bears not the slightest tinge of exaggeration.

Skeptics Overwhelmed

For some time, welding shops displayed thick sections of welded test plates bent double on themselves and flattened into a sharp 180° bend. Such plates were welded with "hot" rods and the number of similar samples became so great as to overwhelm the most confirmed skeptic of the welding industry. Stress-relieved ductilities well over a marked elongation of 30% in 2 in. with a reduction of area averaging close to 60% with consistent cupped fractures proved that with the inception of the flat-position electrode, welding had come of age.

On repetitive work, particularly, the E6020-E6030 electrodes have worked out a definite niche for themselves. With the slightest training, operators are able to deposit perfect weld after perfect weld by letting the coating rest lightly on the work as the arc, almost automatically, consumes the rod and places the bead. A common means of demonstrating the extraordinary worth of this type of electrode was to have a novice weld a test plate with it. In most cases a half hours's training sufficed to enable a beginner to make a weld of good enough quality to pass the most stringent test.

Notwithstanding the spectacular nature of the deeds accomplished with E6020-E6030 electrodes, there are sounder reasons for their widespread use. The number one reason is the extremely high melting rate brought about through high currents and large diameter electrodes. E6010 electrodes are most popular in the $^5/_{32}$ and $^3/_{16}$ in. diameters while the E6020-E6030 electrodes predominate in the $^1/_4$ in. diameter with the $^3/_{16}$ and $^5/_{16}$ in. sizes taking second place. As long as the joint design can handle the heat, the electrode has virtually no limit.

All of the E6020-E6030 electrodes perform well with alternating current while making excellent welds with direct current when either straight or reverse polarity is selected. All suppliers of arc-welding electrodes agree that horizontal fillet welds made with direct current require straight polarity. This choice is based upon a lessened tendency toward undercut. But welds in the flat position, either fillets or groove welds, call for straight polarity when using some electrodes and reverse polarity when using others. However, actual shop experience indicates an almost universal selection of straight polarity in order to gain maximum production rates without any sacrifice of quality of deposit.

It is suggested that even where manufacturers' literature recommends reverse polarity for flat-position welding, a test be made with straight polarity to determine whether or not this latter polarity can be adopted. If it can, there will be a bonus of almost 10% in the additional pounds of metal which will be deposited per hour.

Qualities Lead to Confidence

Smooth beads can be produced with the E6020-E6030 electrodes. Heavy, uniform, wide bands of weld metal such as will be found in the thick-walled pressure vessels attest to good workmanship and lead to confidence in the fabricator. And the welder who is working on weldments of this type enjoys a uniform sidewall wash where the weld metal blends smoothly with the groove walls. Here is an ideal shape on which to place additional weld metal with no fear of slag entrapment. Likewise the smooth section allows ready cleaning of the slag from the groove. Often simple hand tools will suffice for all of the cleaning required.

Table 18—Deposit Analyses Produced by E6020-E6030 Electrodes

	C	Mn	P	S	Si	Ni	Mo	N
Min., %	0.06	0.05	..	..	0.03	...	...	...
Max., %	0.15	0.55	0.04	0.04	0.20	0.025	0.025	0.04

Table 19—Physical Properties of Deposits Made with E6020-E6030 Electrodes

Property	Stress-Relieved	Nonstress-Relieved
Yield point, psi.	47–56,000	52–60,000
Ultimate strength, psi.	60–68,000	62–72,000
Elongation, % in 2 in.	30–38	25–32
Reduction in area, %	40–65	35–60
Izod impact strength, ft.-lb.	50–80	
Density	7.84–7.87	
Endurance limit, psi.	28–32,000	

Arc control is easy with the "hot" rods. A thick, stable coating allows the arc to be maintained over a considerable range of current. In addition the high heat capacity of the electrode means that a good current rate will be used and this greater amperage in itself works wonders in the direction of arc stabilization.

E6020-E6030 electrodes have very heavy coatings with as much as 20% of the total electrode weight being contributed by the coating. As would be expected, the heavy coating produces a considerable amount of slag. Because of the high welding currents employed, the voluminous slag is quite fluid as is the weld metal. It is this combination of properties that prohibits the application of these electrodes in the vertical and overhead positions.

The glowing slag should be left in place until it has cooled. Although the slag left at the end of an electrode may be removed while it is hot and sticky, best practice suggests allowing slag and metal to cool until no color remains. At this point the slag becomes like ordinary glass, being quite friable, while at elevated temperatures it is plastic with a molasses-like behavior that makes slag removal most troublesome.

There are several ingredients used to make the coating of the flat-position electrodes. Among them are found iron oxide, silica, aluminum silicates, magnesium silicates, calcium carbonate, ferromanganese and sodium silicate. Infrequently manganese oxide, titanium dioxide and cellulose may be found. The purpose of each of these ingredients will be discussed next.

Because iron oxide is the base for so many electrode coatings of this division, most of them possess a natural red color. However, where the effect of other ingredients is pronounced or where pigments are used, the color will range from a rather bright red through brown to black. This variation in colors makes the N.E.M.A. two-color scheme all the more important. The main function of the iron oxide in the coating is to provide desired slag characteristics.

Silica is used in these coatings for the same purpose. It aids in the control of slag fluidity which is of utmost importance where a large volume of slag is to be handled by the welder. Good sidewall wash and uniform finishing bead appearance are controlled to a large extent by the amount of silica in the coating.

Aluminum silicates are assigned a dual role in electrode coverings. First the aluminum silicates contribute to the establishment of a balanced slag. Second these silicates may add to arc stability where they contain alkaline earth oxides.

Magnesium silicates are good slag formers and are used for that purpose. It must be remembered that the earliest coated electrodes had asbestos (magnesium silicate) wound around the core wire in the form of a string or tape which with slight modification formed a suitable slag.

Calcium carbonate has been explained as performing the same functions as the aluminum silicates. It aids in the development of a satisfactory slag blanket while helping with arc stabilization. As a matter of fact the arc stabilizing features of the calcium carbonate are supposed to be several times more powerful than those of the aluminum silicates.

As was the case with each of the electrodes discussed before, ferromanganese is present. In this class of electrodes it has three essential purposes. Ferromanganese is a slag former leading to a friable slag that may be cleaned from the weld with little effort. Ferromanganese is a strong reducing or deoxidizing agent necessary to the production of sound weld deposits. It is an alloying agent useful in restoring the carbon and manganese that were burned out of the core wire during the passage through the arc.

Behaves Like Silica

Of course the sodium silicate serves as a binding agent to cement the coating materials to each other and to the wire. As would be expected from its chemical composition, sodium silicate contributes to the slag produced by the coating, behaving in about the same manner as silica.

Where manganese oxide is included in the coating it works as a slag former, promoting friability, and as a contributor of manganese to the weld pool. Titanium dioxide performs as an arc stabilizer and adds to the slag properties. Cellulose is added as a gas shielding element although the small amount generally used cannot help overly much in this direction. It may have some beneficial effect in the manufacturing process to explain its use.

The E6020-E6030 electrodes are essentially unalloyed although small amounts of molybdenum have been added sometimes to improve tensile strength. Deposit analyses show the usual mild steel distribution of elements as is disclosed in Table 18. Here again a wide variation exists between maximum and minimum values. Carbon may run as low as 0.06% provided that the manganese exceeds 0.25% and the silicon content is enough to aid in strengthening the deposit. Some nitrogen may benefit the strength properties, also.

It is strange, however, to review the outstanding physical properties of weld deposits which seem unbelievably high when the chemistry of the metal indicates such a paucity of strengthening elements. The refining action of the slag plus the rapid cooling of the deposit that yields a material of exceptionally fine grain for a cast structure must be partly responsible for excellent strength.

Now that physical properties have been introduced, they are reported in Table 19 where it may be well to examine them. There is nothing unusual to observe in either the tensile strength or the yield point as these are comparable to values reported for other electrodes in the E60xx series.

But, the ductility values are outstanding. No other electrodes can match these values outside of the highly alloyed varieties such as are encountered in the stainless steels and in some nonferrous materials. Many *as-welded* test pieces will show an elongation in 2 in. of better than 30%, while *stress-relieved* test pieces will often be found with elongations in the neighborhood of 35% and more. Weld soundness (the "hot" rods are noted for their ability to deposit the soundest welds that can be made) may have a great deal to do with the fine elongation values obtained with this group. For porosities act as notches in tensile specimens, promoting premature failure. When no porosities are present to start notching, the full ductility of the weld metal can be realized.

Small Sizes of Limited Use

Current and voltage ranges such as are shown in Table 20 lead to some logical observations based upon

Table 20—Current and Voltage Ranges for E6020-E6030 Electrode Application

Size of Electrode, In.	Recommended Amperes	Recommended Volts
1/16	40–60	...
5/32	50–100	18–28
1/8	90–150	22–30
5/32	120–220	24–33
5/16	160–285	26–35
7/32	220–340	28–36
1/4	250–450	29–44
5/16	350–525	32–46
3/8	400–700	34–46

actual fabricating experience. In the first place it is difficult to explain the inclusion of values for 1/16 and 3/32 in. diameters as there can be but limited use for such sizes. As was explained before, E6020-E6030 electrodes are designed for high currents on steels of ample mass to permit the proper absorption of large heat releases. This in itself has led to the selection of minimum diameters in the range of at least 5/32 or 3/16 in.

Small diameter electrodes must be used for some special applications for which the other types may not be selected due to some peculiar circumstances. In general, for routine welding of light structures, E6012 and E6013 electrodes are best. If "hot" rods are tried on light gages, extremely low current values become necessary. Under these conditions the arc is most unsteady and the slag tends to freeze in a helter-skelter pattern that reveals a rough, unsightly bead after the slag is removed.

There is one application for small diameters of flat-position electrodes, though, and that is the use of 1/8 and 5/32 in. diameters for tacking prior to the use of the submerged melt welding process. Here the soundness of the weld and the character of the deposit are best adapted to the subsequent heavy fusion action of the submerged arc-welding method. However, this application satisfies the basic need for heavy plate section as the automatic process is particularly intended for the welding of heavier plate.

Seven approvals are listed for E6020-E6030 electrodes in heavy fabrication work:

American Bureau of Shipping, H1F, H2F, B1F.
A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels, Paragraph W-520.
A.S.M.E. Code for Unfired Pressure Vessels, Paragraphs U68, U69, U70.
Bureau of Ships Specification 46E3 (INT), Grade II, Classes 2 and 3.
Department of Commerce, Bureau of Marine Inspection and Navigation.
Hartford Steam Boiler Inspection and Insurance Company.
Lloyds Register of Shipping, Section 4, Paragraphs 1–9.

This shorter list (there were nine approvals listed for E6010 electrodes) does not indicate any lessened ability to pass tests. Rather the limitation of the flat-position electrode to heavy work in either the horizontal fillet or down-hand position supplies the explanation.

Storage problems are relatively nonexistent with this class of electrodes. They can be stored almost indefinitely in a dry building. If the storage atmosphere is slightly moist, the coating may become whitish in appearance. This white film can be brushed away with the fingers and is not considered harmful to the performance of the electrodes. Variable moisture contents are considered by some as leading to X-ray porosity which explains a widespread use of heated-storage cabinets in some localities. As long as the heat stays below 200° F., the "hot" rods of most brands will be dry and ready for use without the danger of overdrying that exists with some of the grades previously reviewed.

Deep Fillet Welding Pays

Some factual reports to back up a wide variety of storage places and some rather peculiar practices (as extreme as shorting each electrode prior to use or burning away 1 in. of electrode on scrap plate before welding on work to be X-rayed) would be a worth-while contribution to the fabricating industry.

During 1943 considerable publicity and several articles were devoted to the deep-fillet welding made possible with E6020-E6030 electrodes. Many worthwhile savings resulted in industries where this practice had not been used before. Although there was nothing essentially new about the application in many plants, the outstanding development of procedure in the coast shipyards brought the method to a refined state where much money and, equally important, many valuable man-hours were saved.

The applications of the flat-position electrodes are so numerous that only a few of the most important ones will be listed. These include shipbuilding, fabricated structural shapes of large sections, heavy pipe and piping, boilers, pressure vessels, massive machinery such as huge presses and brakes, heat exchangers and heavy truck chassis.

This completes the series of articles on unalloyed electrodes while two succeeding articles will show the advantages of a half per cent of molybdenum added through the electrode coating to develop unusual strength in welding high-strength and carbon-molybdenum steel.

Part VII—Class E7010 Electrodes

PRECEDING articles in this series have presented a comprehensive study of unalloyed carbon steel coated electrodes. All welding of ordinary strength plain-carbon steels can be accomplished with one of the six grades considered. Or, for that matter, all such welding could be completed with the E6010 grade if any fabricator was willing to sacrifice production costs and weld appearance for the sake of a greatly simplified electrode inventory. Now, in this article, the dividing line between unalloyed steels and the alloyed constructional steels is crossed.

Just as was the case with E6010 electrodes, class E7010 are all-position electrodes. Thus they work well in flat, vertical overhead and horizontal fillet positions. Fundamentally they are lightly coated and depend upon gas shielding to protect the weld deposit from the unde-

sirable elements of the ordinary atmosphere. Like the E6010 electrodes, and possibly to an ever greater degree, the E7010 variety produces welds of acceptable X-ray quality.

There are 15 suppliers of E7010 electrodes while there were 23 suppliers for the E6010 group. Actually, as will be suggested later, there are fewer than 15 different electrodes that meet the real need for an electrode that deposits weld metal containing 0.50% molybdenum as required by the Navy and other specifications. However, all those shown are reported to satisfy the demands of the E7010 classification. To do so, the stress-relieved deposit has a minimum ultimate tensile strength of 70,000 psi. while all of the other mechanical properties remain unchanged as compared with electrodes in the E6000 groups with minimum ultimate tensile of 60,000 psi.

Manufacturers' literature suggests that E7010 electrodes can be selected for welding any of the following constructional or proprietary alloys: Armco HT, carbon manganese, carbon molybdenum, Cop-R-Loy, Cor-Ten, Cromansil, Dyn-El, Hi-Steel, H. T. 50, I. H. S., Jal-Ten, Man-Ten, Mayari, Mayari R, M-A-X, R. D. S., Sil-Ten, structural silicon steels, 2 to $3^1/_2$ nickel, vanadium steel and Yoloy. In the foregoing list, names of alloy constructional steels are given in lower case letters whereas names of proprietary alloys are capitalized.

The structural steels are made by many mills while the proprietary alloys are special analyses established by particular mills to give specific high strength and good ductility characteristics. Both of these groups will be found extremely desirable in postwar activities where high strength, light weight products with better than average resistance to atmospheric corrosion are needed.

All of the high-strength steels mentioned have been developed with the need for good weldability in mind. For this reason the carbon content is held low. Furthermore, the carbon and manganese contents are both balanced with the other elements that promote hardenability, keeping in mind the basic consideration that weldability is for all practical purposes the antithesis of hardenability. However, some of these materials remain sufficiently susceptible to hardening to require preheating, especially in the heavier sections, if best properties are to be obtained.

High Strength—High Alloy

In Table 21 will be found the deposit analyses reported for the many brands of E7010 electrodes. Some comments on the different elements will provide a better understanding of the entire group. To explain the increase of 10,000 psi. in the ultimate strength, there is the noticeably increased manganese content of the weld metal and the obvious inclusion of alloys such as molybdenum and chromium. Most of the E7010 electrodes contain from 0.40 to 0.60% molybdenum and no chromium. They are so alloyed because of the limitation established by the Bureau of Ships' specification 46E2 for classes 1 and 4 as well as to agree with the needs of governing bodies that supervise work utilizing carbon molybdenum piping for high-temperature high-pressure steam service. For the many other applications, however, chromium will serve most effectively as a strengthening agent. In at least one electrode both molybdenum and chromium are included.

Table 21—Deposit Analyses Produced by E7010 Electrodes

	C	Mn	P	S	Si	Mo	Cr
Min., %	0.05	0.35	..	..	0.08	0.025	0.025
Max., %	0.12	0.80	0.03	0.04	0.30	0.60	0.50

Table 22 discloses details of the physical properties of the E7010 electrode weld metal. It is interesting to note that several producers of these electrodes report values for the *as-welded* and for the *stress-relieved* states although the A.W.S.-A.S.T.M. specification as recently revised (it is currently A.W.S.-A.S.T.M. A233–43T) calls for values in the latter condition only. Yet when it is recalled that practically all of the proprietary alloy are intended for use in the *as-welded* state, it is well to have this information.

Table 22—Physical Properties of Deposits Made with E7010 Electrodes

Property	Stress-Relieved	Nonstress-Relieved
Yield point, psi.	57–65,000	61–66,000
Ultimate strength, psi.	70–79,000	77–87,000
Elongation, % in 2 in.	22–31	20–24
Reduction of area, %	40–64	30–55
Izod impact resistance, ft.-lb.	30–70	
Endurance limit, psi.	42–46,000	
Specific gravity	7.84–7.86	

Figures for impact resistance show no improvement over those given for the E6010 electrode group. But when low temperatures are reached, for example 50° F. below zero, the E7010 electrodes containing molybdenum will show some definite superiority. Although nickel is usually considered to be the alloy for low-temperature applications it will be found that molybdenum occupies a place between carbon steel and nickel alloys in low-temperature impact resistance.

E7010 electrode deposits show an improved endurance limit which again must be attributed to the alloy content. In those machinery parts where both welding and fatigue resistance enter the picture, these electrodes are well worth considering.

Ranges for current and voltage as shown in Table 23 are more restricted than was the case with E6010 rods. It is quite likely that the narrower ranges are indicative of the more precise control usually adopted for weldments where the E7010 electrodes are applied. This is alloy work of a nature that either suggests a critical use or means an expensive structure. In either case quality requirements are high and the welding must be done according to a precise pattern under good procedure control.

Table 23—Current and Voltage Ranges for E7010 Electrode Applications

Size of Electrode, In.	Recommended Amperes	Recommended Volts
$^5/_{32}$	40–75	23–25
$^1/_8$	75–140	23–26
$^5/_{32}$	90–180	24–26
$^3/_{16}$	140–230	24–27
$^7/_{32}$	160–270	27–29
$^1/_4$	190–325	25–32
$^5/_{16}$	250–400	30–34

Only four approvals are given for the E7010 electrodes:

American Bureau of Shipping, HlG, BlG.
A.S.M.E. Code for Unfired Pressure Vessels, Paragraphs U68, U69, U70.
Bureau of Ships Specification 46E4 Classes 1 and 4.
Department of Commerce, Bureau of Marine Inspection and Navigation.

It is suspected that numerous other approvals have been granted. At any rate it is known that the alloy electrode groups are applied under the most rigid and detailed procedures of any metallic arc-welding electrodes.

The ingredients found in the coating of the E701 electrodes are quite similar to those discussed for the E6010 group. They are essentially cellulose as the major gas-forming material, titanium dioxide as an arc stabilizer and slag former, mangesium or aluminum silicates for slagging properties, ferromanganese as a degasifier and sodium silicate as a binding agent.

Molybdenum Addition Desired

In addition ferromolybdenum or some other form of molybdenum addition agent is included in the coating to provide the alloy desired. Or in some cases an alloy core wire may be selected to furnish the molybdenum, but this practice is not general in the field. Finally those electrodes with chromium in the deposit depend upon ferrochromium or powdered chromium for this element. Again a chromium alloy wire can be used but ordinarily is not.

As was the case with the E6010 electrode group, the small diameters predominate. As a matter of fact, the diameters in the E7010 classification are one step smaller than those of its unalloyed counterpart. E6010 electrodes, it will be recalled, find their greatest application in the $^5/_{32}$ and $^3/_{16}$-in. sizes while the E7010 electrodes are most popular in the $^1/_8$ and $^5/_{32}$-in. sizes. The end use of these alloy electrodes provides an explanation.

Of the 21 steels mentioned at the beginning of this article as being weldable with E7010 electrodes, 15 are proprietary alloys. All of them are characterized by a high yield strength, high ultimate strength and good ductility. Along with these excellent physical properties, most of them possess good corrosion resistance. Such properties are ideal for the transportation field where light weight construction leads to lower operating costs.

The low-alloy high-strength steels have a bright future in rail and motor transport service. Here light gages undoubtedly will be employed. Light gages, in turn, suggest the use of small diameter electrodes which explain the preponderance of sales in the $^1/_8$ and $^5/_{32}$-in. sizes.

Another factor serves to increase the use of these rods in welding low-alloy steels. Although yield strength and ultimate strength are raised, the modulus of elasticity remains practically unchanged. Designs with thin sections following the customary practice would be too limber or flexible for transportation services. Therefore, the designer needs considerable ingenuity in devising shapes that combine the high strength properties with adequate rigidity. Fabricated sections of many types have been devised to coordinate a desirable section modulus with a necessary set of strength characteristics. In this way a press brake, a shear and imaginative welding practice provide ideal transportation units.

There are six types of low-alloy steels made by many different steel producers. These as well as the proprietary steels are often welded with E7010 electrodes notwithstanding the wide differences in analyses. For experience has demonstrated that weld deposits from this group of electrodes stand up well in corrosive services of the same degree as those encountered by the steels.

Susceptible to Severe Corrosion

It may be well at this point to re-emphasize the fact that these steels are primarily intended for better resistance to atmosphereic corrosion and are not, generally speaking, designed for severe corrosion conditions. Thus both the proprietary alloys and the structural alloy group may be welded with E7010 electrodes. However, there are reasons for using special electrodes with the structural alloy steels and these will be considered briefly.

Carbon-manganese steels are like ordinary plain carbon steels except for an increased manganese content intended to raise the strength of the steel. E7010 electrodes give a higher manganese deposit than the E60xx types and for this reason work well with carbon-manganese steels. If the carbon plus one-sixth the manganese adds up to more than 0.25%, preheating is a good precaution to insure crack-free joints.

Carbon-molybdenum steel may well be the most popular type that is joined with E7010 electrodes. Two extensive fields exist for this analysis which is usually spoken of as "carbon moly"—pressure piping and pressure vessels. Molybdenum improves the creep resistance, thereby furnishing a special property that is necessary to good metallurgical practice in the power plant and petroleum refinining industries.

Pressure may run as high as 2500 psi. with temperatures up to 900° F. These are severe service conditions which are virtually impossible to satisfy with bolted connections. The record shows that many important advances in power plants and refineries were made possible by the successful development of E7010 electrodes and a suitable welding process.

Although many pressure vessels are welded with E7010 electrodes, the main seams are most often made with E7020-E7030 electrodes while the fittings are fabricated with both types. Field joints depend almost entirely on the E7010 group. Preheating to 400° F. is suggested when the carbon runs 0.18% or more or when the section thickness is $^3/_4$ in. or greater. In case of doubt, preheat, as no structure of carbon moly steel is ever harmed by preheating before and during welding.

Very strict practice in the field of pressure piping almost always specifies preheating to a minimum of 400° F., while some shops customarily go to 600° F. or even slightly higher. Actual welding practice at these temperature levels differs little from that employed in carbon steel piping work except that the hot metal means a lower amperage for the electrode. Cleaning of slag between passes is done with the utmost care to insure perfect joints. X-ray inspection is quite common as another means of insuring satisfactory joints.

Stress Relieved in Portable Furnace

Most specifications for power piping insist upon stress relieving which is done with portable gas or electric furnaces with automatic control. A band that includes the weld and at least six times the wall thickness of the pipe on both sides of the joint is heated at a prescribed rate to 1200–1250° F., held for at least 1 hr. per inch of thickness and cooled at a predetermined rate. Thin walled pipe (in this service about $^5/_{16}$ in. and lighter) may be installed in the as-welded condition. Since thousands of power piping joints must be made on the job with the

pipe in its final position, the use of E7010 electrodes with their desirable all-position welding attributes is virtually universal.

Cromansil steel contains from 0.40 to 0.60% chromium and has 1.25% or more manganese along with more than 0.50% silicon which definitely places it in a higher strength classification than is uaually felt to be proper for low-alloy high-strength steels. Of course, Cromansil may be fabricated with E7010 electrodes by using large fillets but special electrodes in the E80xx and E90xx series appear to be a more reasonable choice. Fabrication of this steel is seldom undertaken without the advice of an experienced welding engineer who is able to decide the best electrode and the correct procedure for each particular job.

Structural silicon steels depend for their strength upon carbon in the neighborhood of 0.30%, manganese around 0.80% and sillcon from 0.15 to 0.30%. E7010 electrodes work very nicely when all-position welding of structural silicon steels is desired. Preheating serves a useful purpose in preventing the development of cracks and should be done at about 400° F. Without preheating a material containing as much carbon and manganese as these silicon structural steels would be designated as unweldable.

Nickel steel containing between 2 and 3.5% nickel is used primarily for low-temperature service and secondarily in locomotive boilers. Very often this steel is partly fabricated with E7010 electrodes although most welding is done with nickel steel electrodes. Here again all-position welding must be done with the E7010 type as no manufacturers list a nickel alloy electrode for such applications. For down-hand welding, however, nickel electrodes are available and remembering that nickel gives the best low-temperature impact resistance, the work should be positioned to permit the use of nickel steel electrodes.

Vanadium steel is quite often called manganese-vanadium steel and contains little carbon, less than 0.15%; with considerable manganese, about 1.75 to 2.00% and from 0.15 to 0.25% vanadium. E7010 electrodes may be selected for some weldments using preheat to 400° F. The full story on this steel will very likely be told after the war.

Some Similarity with E6010

E7010 electrodes are similar to E6010 electrodes in their response to storage conditions. It is inadvisable to purchase more material than the job at hand requires. For most alloy electrodes are used on work that is special and extremely important. Usually because of the many precautions to be taken, low-alloy high-strength weldments are costly and the electrodes are a very minor item in the cost of the job. Remembering this, the use of fresh electrodes is quite important.

Moisture appears to be the greatest enemy of E7010 electrodes. They should be kept in a warm, dry place. Storage life is good for at least six months and may be extended to a year or two under ideal conditions. Damp electrodes, in those climates where it is impossible to keep the electrodes from picking up undesirable moisture, can be restored to good operating performance by drying at 150° F. for at least 1 hr. before use.

Many different steels are welded with E7010 electrodes. Just as the E6010 type was the closest approach to a universal electrode in the carbon steel division so the E7010 type comes the closest to universality in the alloy steel division. Where electrode analyses may be matched to the plate material with many of the E7010-E7030 brands, it is found that no such choice of electrodes exists in the E7010 classification. However, this is not necessarily a hardship.

Not all alloy steel welding must be done with an alloy steel electrode. The aircraft industry, for example, uses E6012 and E6013 electrodes in the fabrication of alloy steel tubing. This work is successful because of the unalloyed weld mixes with the alloyed parent metal during the welding operation and thereby forms a more dilute alloy. Since weld metal is commonly stronger than rolled steel of the same analysis, a lesser alloy provides plenty of strength in the form of weld metal.

At present the quantity of alloy steel electrodes is extremely small as compared with the use of unalloyed welding rods. This situation, the customary manifestation of the supply and demand law, is a partial explanation of the standardization on E7010 electrodes for a host of proprietary alloys. As the use of the low-alloy high-strength constructional steels expands, it is reasonable to expect an increasing variety of E7010 electrode analyses. Still with the increasing engineering experience and evidence pointing to successful service records where the present E7010 electrodes have been applied, it may well be that there is no need for a greater number of E7010 alloy electrodes.

Welding procedures for the E7010 electrodes are exactly the same as those for the E6010 group. It is the steels on which they are used rather than the electrodes that are responsible for the several preheating and postheating suggestions that have been made.

Part VIII—Class E7020 Electrodes

THIS discussion will deal with class E7020 electrodes, ignoring the few E7030 types that are available. For as was pointed out when the E6020-E6030 electrodes were discussed there is little to distinguish between the two grades in present-day practice. The E7020 electrodes will do everything the E7030 electrodes are capable of doing and will make satisfactory horizontal fillet welds besides.

Of course, the E7020 electrodes are intended primarily for welding heavy steel sections, at least $^3/_8$ in. in thickness, with the structure being positioned to allow down-hand welding or at most horizontal fillet welding. The deposit is quite fluid and the slag is voluminous while the high currents used automatically result in excellent rates of deposit.

While the E7010 electrodes were suggested for welding both the proprietary high-tensile low-alloy steels and the structure alloy steels, it will be found that E7020 electrodes are used almost exclusively with the latter materials. There is good and sufficient reason for this as the bulk of the proprietary alloys are fabricated in light sections with but a comparatively small percentage of these steels being fabricated in the heavier gages. Therefore, thickness considerations lead to the selection of E7020 electrodes.

Three Steels Consume Most

E7020 electrodes are selected for work with the fol-

lowing steels: carbon manganese, carbon molybdenum, Cromansil, structural silicon steels, structural nickel steels and vanadium steel. Three of these steels—namely, carbon molybdenum, structural silicon and nickel steels—account for most of the electrode consumption with the relative importance of the three coming almost in the order named. For this reason a good approach to the application of this group of electrodes will be found in a discussion of the three steels for which they are so well adapted.

Considering carbon-molybdenum steel first, a typical analysis will show carbon 0.20%, manganese 0.66, silicon 0.20 and molybdenum 0.46 with a small amount of phosphorus and sulphur as impurities. The molybdenum serves a dual purpose being effective in raising the tensile properties of the steel about 10,000 psi. over the values to be expected without the alloy and being helpful in imparting outstanding creep strength to the metal. Both of these factors have led to the adoption of carbon-molybdenum steel in the fields of pressure vessels, pressure piping and transportation equipment.

Carbon-molybdenum steel pressure vessels are useful for high-temperature high-pressure applications in power boilers and refinery vessels. Power boilers of the locomotive and stationary types are often built with this steel because thinner walls may be used with safety due to the greater strength of this alloy and because creep strength will maintain the wall thickness under prolonged stress at elevated temperatures. Of course, the molybdenum does not impart any extra corrosion resistance which explains the use of alloy liners where corrosive oils are encountered.

Almost the same reasons prevail for the choice of carbon-molybdenum steels in the pressure piping field. If anything, service conditions in piping may be more severe than those in pressure vessels which explains a growing demand for molybdenum bearing steels, Since bolted connections are often troublesome as well as cumbersome in high-pressure steam distribution systems, jointless piping offers many advantages. Prefabricated piping with as many joints as possible made in the shop predominates and E7020 electrodes make the welds as the pipe is rotated by positioners to permit flat-position welding.

Saves Weight in Diesels

In the transportation field the use of carbon-molybdenum steels for locomotive boilers has already been mentioned. But Diesel as well as steam locomotives depend upon carbon-molybdenum steels in their power units. Perhaps the greatest single contribution to the elimination of dead weight in Diesel engines has been the arc-welding process. High-strength steel joined with E7020 electrodes in a strong, compact assembly under the guidance of able designing engineers has brought the weight per horsepower of Diesel engines to a remarkably low point. Naturally these same Diesel power units are found in seagoing vessels of many descriptions although the full story of these applications must await the winning of the war.

Transportation uses in addition to the foregoing include main strength members of railroad cars and trucks where the elimination of dead weight through the use of carbon-molybdenum steel is a common practice.

Structural silicon steels have carbon as high as 0.35% with manganese running up to 0.90% and silicon from 0.15 to 0.30%. The rather extreme values of carbon and manganese are necessary because the structural silicon steels must exceed 70,000 psi. minimum tensile strength as-rolled. Carbon, manganese and silicon are increased as the section thickness becomes greater in order to maintain the required strength.

All sorts of pressure vessels are built of structural silicon steels primarily because of the strength chracteristics of this material. Oftentimes high-tensile silicon steels are suggested by fabricators who otherwise would be unable to build the larger units because of crane and handling limitations. From the standpoint of lower fabrication and transportation costs, the high strength materials are selected notwithstanding their higher initial cost. Naturally it is cheaper to weld 2 in. thicknesses of high-strength steel rather than $2^1/_2$-in. thicknesses of low-carbon steel when all essential features of the process for welding heavy plate are the same.

Nickel steels contain from 2.0 to 3.5% nickel with carbon in the neighborhood of 0.20% and manganese less than 0.80%. Once more high-strength characteristics are important although the most unique property of these steels is their ability to absorb shock at low temperatures, that is, they possess good impact strength which makes them useful where shock at 50° F. below zero would be most hazardous.

One of the earliest uses for welded nickel steel vessels was the low-temperature dewaxing of oil. The manufacture of Dry Ice (solid carbon dioxide) is yet another application for nickel alloy steels. Liquefied gas storage has opened up another field to the nickel alloy steels. Our newest large scale synthetic industry, censorship prohibits any more positive identification, employs nickel steels quite freely.

Although casting analyses will be found that match all of the three steels just covered, there are other alloy castings that perform similarly with chemistry that is different from those elements and percentages common to the wrought steels. However, casting repairs, particularly when large castings are involved, provide a large outlet for E7020 electrodes.

There are thirteen manufacturers of E7020 electrodes. Of these three manufacturers show more than one electrode in the E7020 group. This state of things exists to provide different analyses and compositions to allow the best matching of steel and electrodes. Unfortunately some of the low-alloy high-strength steels appear to require particular care in electrode selection to obtain the best welding results.

Obvious defects show up in the surface of the weld deposit when an improper choice is made. It is a good idea to discuss the choice of electrodes with the manufacturer before choosing one for use with an alloy steel that is being fabricated for the first time. Some fabricators ask their purchasing departments to show the analysis of A.S.T.M. specification covering the steel to be welded when orders are placed for electrodes.

Deposit analyses for the weld metal from E7020 electrodes is given in Table 24. As usual it will be noted that the carbon content of the weld deposit is low. However, there is appreciable manganese available while the silicon and alloy add their bits to gain the desired strength. Silicon is seldom as low as 0.02%.

Table 24—Deposit Analyses Produced by E7020 Electrodes

	C	Mn	P	S	Si	Mo	Ni
Min., %	0.07	0.26	..	..	0.02	0.20	..
Max., %	0.12	0.60	0.04	0.04	0.20	0.60	2.30

In the molybdemun types of E7020 electrodes, the molybdenum will be found between 0.40 to 0.60%, whereas in the nickel types of E7020 electrodes the molybdenum varies between 0.20 and 0.30% according to the

literature of the sole manufacturer who lists this type of electrode. In the nickel alloy electrode from 2.0 to 2.3% of nickel is present in addition to the molybdenum.

Based solely upon the information given to the author by various welding fabricators it is understood that the molybdenum alloy E7020 electrodes are much more widely used than the nickel alloy type because of the greater production of products utilizing carbon-molybdenum or silicon structural steel rather than nickel steel. However, where nickel alloys are essential to the process, preference has been given to the nickel electrode. This does not preclude the use of electrodes alloyed with molybdenum for welding nickel steel, though, as many weldments have been successfully completed with the latter electrode. If the designer wishes to match weld and plate analysis as closely as possibly, the nickel electrode provides that option.

Use of Test Plate Wise

It may be worth while to point out a discrepancy between A.W.S.-A.S.T.M. A233–43T and manufacturers' literature in discussing the physical properties of E7020 weld deposits. As may be noted in Table 25, the yield point for this group ranges from 52,000 to 63,000 psi. Now the specification requires a minimum yield point of 57,000 psi.

Table 25—Physical Properties of Deposits Made with E7020 Electrodes

Property	Stress-Relieved
Yield point, psi.	52–63,000
Ultimate strength, psi.	70–80,000
Elongation, % in 2 in.	25–32
Reduction in area, %	40–65
	As-Welded
Izod impact resistance, ft.-lb.	30–50
Endurance limit, psi.	40–45,000
Specific gravity, gm./cc.	7.84–7.86

Therefore, it may be desirable to check the values of the welded joint by means of a test plate before embarking upon an extensive fabrication program. Here is another instance where the Bureau of Ships has less severe requirements as their specification shows a yield strength of 40,000 psi.

During any discussion of the welding of carbon-molybdenum steel with electrodes of a similar composition, mention ought to be made of the response to stress relieving exhibited by the weld metal. With most steels the stress-relieving heat treatment reduces the yield strength and the ultimate strength. At the same time the ductility increases. This relationship has been well established by thousands of tests and is an accepted rule.

But carbon-molybdenum weld metal works differently. After stress relief, its tensile strength may be the same or slightly less than before heat treatment; its yield strength will be unchanged or even greater than it was before stress relieving; and its ductility follows a normal pattern by becoming greater.

This unusual, albeit highly desirable, behavior is illustrated in Table 26 with figures taken from "Molybdenum in Steel" published by the Climax Molybdenum Co. The tensile impact values taken in the longitudinal direction are included to show that the impact strength behaves similarly to the ductility. This test was carried

Table 26—Effect of Stress Relieving on Physical Properties of Carbon Molybdenum Weld Metal

Property	Weld Metal	
	As-Welded	Stress-Relieved
Yield point, psi.	63,800	65,300
Ultimate strength, psi.	85,600	83,800
Elongation, % in 1 in.	29.2	36.0
Tensile impact (longitudinal), ft.-lb.	763.7	787.7

out by stress relieving at 1110° F. for 6 hr. but similar results have been obtained with 1150 and 1200° stress-relieving treatments which are used as standard temperatures in the welding industry.

Table 27 reports the ranges in welding current and arc voltage applicable to E7020 electrodes. Remember these, too, are "hot" rods and as such are intended for use at high-current densities in order to get the speed and soundness for which these electrodes are designed. A

Table 27—Current and Voltage Ranges for E7020 Electrode Applications

Size of Electrode, In.	Recommended Amperes	Recommended Volts
1/8	65–150	22–30
5/32	100–220	24–33
3/16	150–285	26–36
7/32	200–340	28–36
1/4	250–450	29–44
5/16	250–525	32–46

good procedure is to use as much current as the joint will allow. As long as the slag is readily controlled and the weld metal surface is uniform, current values are not too high. As soon as a long fluid pool develops and the weld metal is rough and raised in the center, it may be assumed that current is too great.

Bug Holes on First Pass

One trouble may be encountered when E7020 electrodes are used for deep groove welding. The first pass or two in the bottom of a U- or V-groove may show a peppering of bug holes in the weld surface. Since this occurrence is restricted to the first passes, it presumably is caused by the steel and weld mixture. Slower travel speeds at reduced currents are suggested to overcome this condition. If it persists, a different type of electrode such as E7010 may be indicated for the first passes. Or another E7020 electrode may eliminate the bug holes.

Only five approvals are listed for the E7020 electrodes:

American Bureau of Shipping, Hl, Bl, HlG, BlG.
A.P.I.-A.S.M.E. Code for Unfired Pressure Vessels, Paragraph W520.
A.S.M.E. Code for Unfired Pressure Vessels, Paragraphs U68, U69, U70.
Bureau of Ships Specifications 46E2, Class 2.
Department of Commerce, Bureau of Marine Inspection and Navigation.

This apparently restricted list reflects the limited applications of E7020 electrodes partly but does not include many of the latest uses for this group which is playing a dominant part in war production work.

No one should assume from the bob-tailed list of approvals that there is any lack of quality in the E7020

electrode group. Even as was the case with the E6020-E6030 electrodes, the E7020 group is the highest quality division of the E70xx bracket. X-ray examination proves that the weld metal is remarkably clean and repeated physical tests demonstrate a combination of high strength with good ductility.

E7020 electrode coatings include iron oxide, silica, aluminum silicates, magnesium silicates, calcium carbonate, ferromanganese, molybdenum containing materials, nickel powder and sodium silicate. Sometimes manganese oxide, titanium dioxide and cellulose are used.

Iron oxide is included in the coating for essential slag-forming characteristics. When it is the predominant pigment it imparts a red color to the coating. Silica is also a contributor to the slagging characteristics. Aluminum silicates likewise impart special slag properties and if they are of the alkaline variety may contribute to arc stability. The magnesium silicates are slag formers, also.

Calcium carbonate has been assigned two jobs in electrode coatings. One purpose is to contribute to desirable slag formation and the other function is that of arc stabilization.

Ferromanganese is one of the most important constituents. About four distinct influences are traced to the ferromanganese. One, it aids in the formation of a friable slag that can be easily removed from the weld. Two, it replaces some of the carbon and manganese lost in the arc transfer from core wire to molten weld pool. Three, it deoxidizes the weld metal removing objectionable gas. And, four, in some forms it improves arc performance by smoothing out metal-transfer irregularities.

Molybdenum-bearing materials are essential to provide the alloy content in the deposit. Molybdenum may be added in any one of three forms with the most popular being ferromolybdenum powder, followed by molybdenum trioxide and calcium molybdate. The transfer efficiency of molybdenum is quite good.

Nickel Usually Added

Nickel is usually added as nickel powder. This element transfers with high efficiency also. Sodium silicate is added as a binding agent to hold the coating powders together and to bind the coating to the core wire.

Manganese oxide may be used in conjunction with ferromanganese to provide another means of adding manganese to the deposit and to make the slag more friable. Titanium dioxide may be included for slagging effect and to aid in arc stabilization. Cellulose is infrequently used for additional shielding.

The shelf life of E7020 electrodes is commonly considered to be good. Like all other types, these electrodes increase in moisture content but no irrefutable evidence has been reported in the literature to show that this moisture is harmful. For that matter nothing has been reported to prove that the moisture is harmless. But observational tests indicate that many E7020 electrodes discharge their moisture during welding, as the open structure of the coating permits the moisture to escape.

E7020 electrodes are the companion electrode group to the E7010 type. The former is intended for high production rates on heavy sections that can be positioned for flat-position work. The latter is designed for all-position welding. These two electrodes comprise more than 90% of those used for the welding of low-alloy high-strength steels.

Much war matériel is being fabricated with E7020 electrodes. Alloy analyses of a so-far-restricted nature are being used for mobile armament where high-strength alloys contribute good strength with light weight. Strict ordnance specifications are being satisfied with E7020 electrode deposits that meet specific yield strength tests with an ample margin while regularly surpassing X-ray inspection standards.

This is the concluding article in the current series which was intended to give a thorough review of the metallic arc-welding electrode situation in 1944. Hard surfacing, nonferrous welding and other special types may be covered later if information can be obtained. With many companies actively engaged in postwar product design and development, it was considered important to make available a comprehensive description of electrode differences. Welding has shown a rapid growth accelerated by armament and associated needs making available much valuable experience for peacetime fabricating efforts.

Since competition is likely to be unusually keen, a precise selection of metallic arc-welding electrodes based upon an ideal balancing electrode type and parent metal should enable the shop to perform its work speedily and economically. Appearances will count more than ever, making the right electrode choice from the standpoint of workmanlike finish a necessity. Suppliers of electrodes will be called upon to offer advice and engineering help in connection with new designs, new steels and improved welding methods.

Low-Frequency Induction Heating

Its Practical Application for Preheating and Normalizing in Connection with Welding and Other Heating Developments

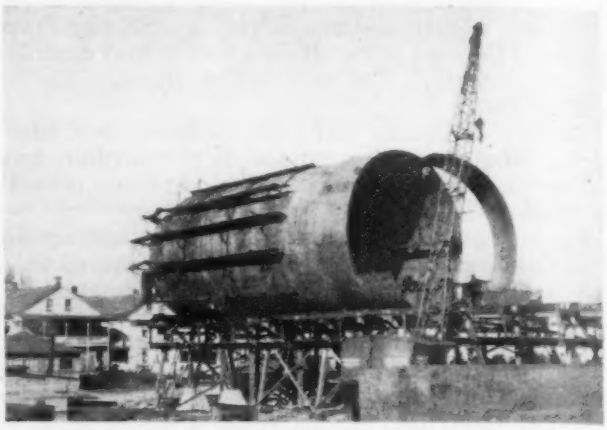
By O. Kreisel*

THE intense heat which is concentrated in one spot on a metal surface by the electric welding arc often sets up internal strains which create a danger of warping and cracking. Experience has shown that the answer to this problem is to *prepare* the metal to receive and absorb these strains by preheating the area which surrounds the weld. In such preheating, the temperature to which the metal should be raised depends on its composition and also upon the type of weld to be made. In any case, it is greatly desirable that this temperature be closely controlled.

Introduction Heating

A powerful electrical field is created in the vicinity of a coil of wire of large diameter and relatively few turns. This coil can surround the work, as in the case of a pipe or shaft, or can be made to conform to the shape of the work, as in the case of a flat plate. The electrical field is efficiently produced by the secondary of a special transformer which delivers a current of high amperage and low voltage. The metal to be heated is placed within the influence of the field so created and the temperature of the entire mass is quickly raised to the desired temperature in a uniform manner. This phenomenon is caused by the electrical induction and transformer effect of the heavy current field, acting throughout the metal mass. It should not be confused with resistance heating, in which a wrapping of hot wire is used to heat the piece from the outside in. This uniform distribution of heat throughout the mass of metal is a noteworthy feature of induction heating. This means exactly the right application of heat for the purpose intended—that of preparing the metal to receive and absorb the strains and stresses *internally*.

* Electric Arc Cutting and Welding Co., Newark, N. J.

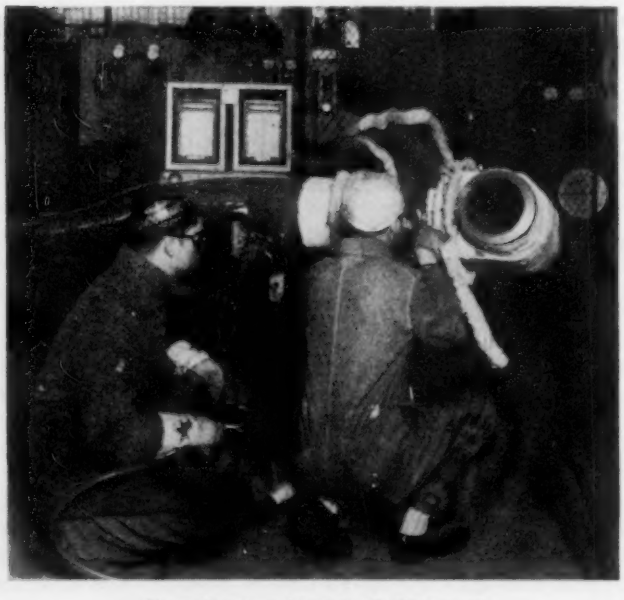


Induction Preheating of High-Pressure Gas Holder 110 Ft. × 30 Ft. × 1 In. Thick

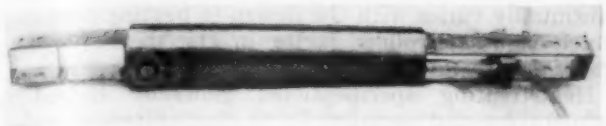
The successful application of the induction-heating method for preheating alloy steels of critical weldability and its use for stress relieving these weldments after completion have in no small measure contributed to the progress of welded high-pressure, high-temperature piping systems. In this, I do not mean to imply that the low-frequency induction heating method was the open sesame for the successful installation of such piping system as other methods of preheating and normalizing namely: the electrical resistance method and the radiant gas burners also apparently accomplish these results.

To my mind, the fact remains that no matter what the welding job consists of, certain basic requirements must be met and with consistent results, and if this depends upon a method of preheating and normalizing, the method used must be taken into consideration, not only as to the cost involved, but should be based on the consistency of the desired results achieved. By this, I do not mean that the cost of the welding operation should be a secondary consideration, but it should not be the governing factor when the safety and success of such an installation depends upon the welded joint, as a haphazard attitude by the constructor and the indifference of the engineer to the difficulty under which his layout must be installed are not conducive to sound progress.

This, then, brings us to the problem which should be investigated preferably by observance and research of these methods of heating for welding in the field and in the shop where, after all, the practibility and success or



Shop Heating Control (No Furnace)



Internal Heater 5¾ In. O.D., 20-In Heating Element

failure of any method is determined. This investigation divides itself into several phases which must be correlated to bring about the results desired, namely: not a particular method of heating but a combination of applications of the methods at hand to bring about consistent results.

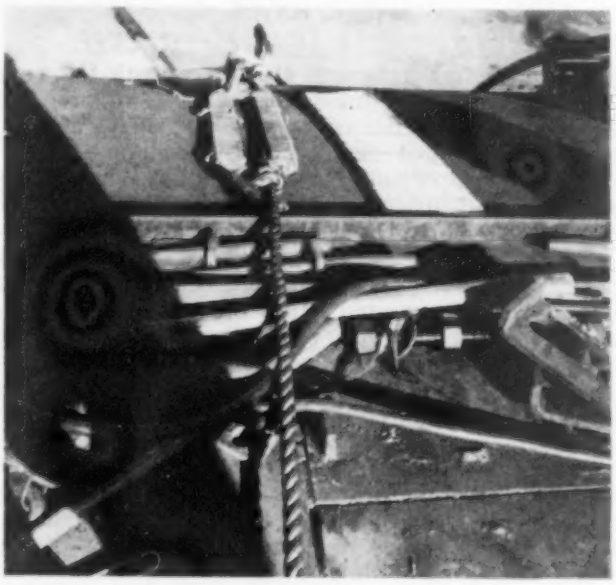
1. The metallurgist must determine for the welding engineer the weldability of the metal and the necessary preheat and reheat temperature, if required, and the cycle of stress-relieving and/or annealing temperature necessary after the weld is complete. The metallurgist, basing his results upon the chemical composition, grain structure, etc., of this metal after it has been welded in the conventional manner from specimens taken from test welds, does not in my estimation have the complete answer, for consideration must be given to the shape and structure of the weldment and how the preheating and normalizing can be accomplished; also what leeway is allowable from the ideal to the welding engineer who has to successfully weld and stress relieve this weldment with consistent results. In short, the metallurgist cannot expect these consistent results if he ignores the fact that a cubic centimeter of a certain metal in an ideal heating furnace will not show the same results when that metal is made up in a complicated shape and ideal heating methods are not applicable.

2. The welding engineer, or whoever is responsible for the welding, must consider the weldability of the metal as ascertained by the metallurgist and should not consider the welding procedure as paramount without due consideration to the prescribed preheating and stress relieving, as specified by the metallurgist.

3. The method used to preheat or stress relieve should not be chosen with the thought in mind that it is but another nuisance and trouble added to an already tough welding job but should be so chosen as to make it a practical and successful application to bring about the specified results and to remember that the heat produced by the preheating is so much saved for the welding and that the welding time is decreased thereby.

4. The designer must bear in mind that the fabricator or constructor is confronted by the ever-present competition which means more products and better product and must so consider his design so that the proper applications of the preheating and stress-relieving operations are considered. Preheating from a specified temperature level irrespective of ambient conditions makes for safety in welding.

5. The proper training of personnel by education as to the heating methods used and proper supervision of this heating and cooling method by instruments or by supervised logging of each welded joint will be one of the principal avenues to increase the scope of welding. It has been my experience that ignorance of what is to be accomplished and absence of knowledge of the operating and setting up of the heating equipment have been responsible for most of the difficulties encountered in the field.



Coil Heater. Tank 30 Ft. × 30 Ft.—1 In.

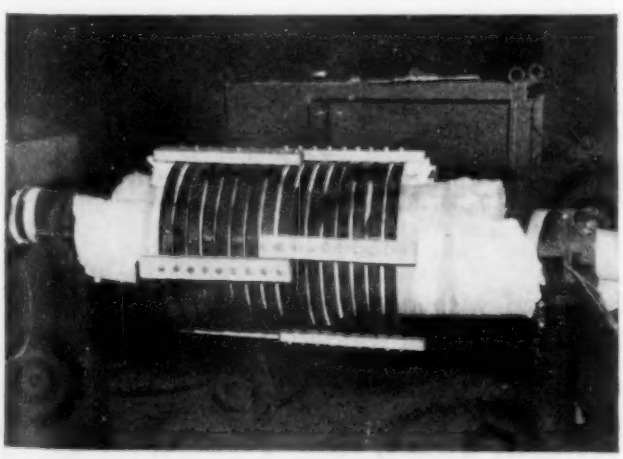
6. A fair investigation of the various methods of heating now used and an evaluation of the advantages of each so that the choice of the heating method may be such that the method used may be most advantageous for consistent results.

The low-frequency induction heating method has the advantage in that it heats the metal where this heat is required, heats it uniformly throughout its entire thickness and does it in such a manner that the operation is not delayed but accelerated. This is dependent upon the proper application of the induction coils which can take the form of common cable wound on asbestos insulation around the weldment or, wherever close quarters are encountered, can be made up of small water-cooled coils, or smaller cable can be used with 180 or 240 cycle induction heating equipment.

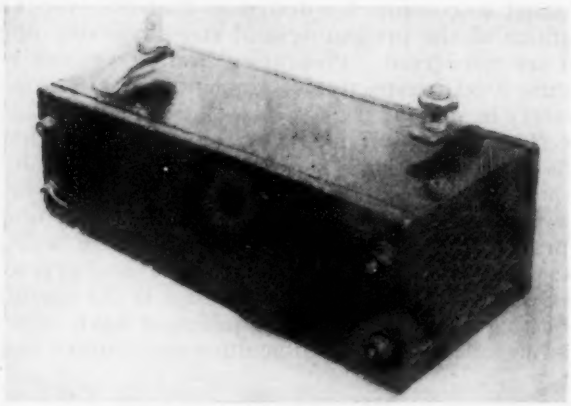
Flat-type induction heating coils have been developed for preheating of large pressure vessels such as boiler drums, heavy steel plate or any flat surface which must be preheated before it is welded. These flat type heaters can be supported in such a manner as to clear the object which is being welded so that it can rotate or move past the plate heater or vise versa. This arrangement is especially desirable where automatic welding equipment is used.

This method of induction heating as described above has been used successfully by the U. S. Navy for heating of large propeller shafts for straightening same.

The cycle or time of heating as well as the maximum or intermediate temperature can be controlled accurately and automatically. A similar method is popular for



Stress Relieving 6 in Steel Flanged Pipe Utilizing Prefabricated Induction Coils



Angle Heater Flat Plate Type

bending and stress relieving, thereafter, with the same coil arrangement. Shrink fitting of bolts or prepared forgings are ideally heated by this method to any desired and controlled dimension by reaching the corresponding temperature automatically. Where coils can be inserted inside sections or pipes before welding and can later be removed, heating is particularly effective and nonferrous metals can be heated very readily by this method. The induction heating apparatus required can be connected to any commercial frequency and the heating current can be conducted any reasonable distance from the heating unit without too much difficulty. Operation of the equipment is simple; even the automatic pyrometer equipment has been developed to be completely operated without human supervision.

One thing to bear in mind is that the recording couple which supervises the heating of the weldment is but a very small point of the entire section so that reliance must be placed upon the proper application of the heating coils to the work which, once ascertained, is always the same for the same job.

The metallurgist may require slow heating and very fast cooling for an artillery shell—yet insist on slow cooling for another product made from the same metal. The ceramist may call for fast melting and extraordinary slow cooling for a telescope lens—and reverse the order for another glass product. This indicates the distinction between heat generation, heat application and heat utilization in the process of heating and cooling industrial products; and with particular reference to the factor of *rate of transfer* in relation to the composition and geometry of the individual piece.

There is no direct relation between any form of fuel, electricity or method of heat release and the result sought in finished product. Each has a field of usefulness that continually varies with the design of heating equipment which is a controlling factor in the method of heat transfer.

Heat-treating specifications, generally limited to temperature and occasionally to temperature and time, are fundamentally unsound, or at least incomplete, when they merely refer to a given material without reference to a specific product made from that material. Obviously, a ball, cube milling cutter, gear blank and gear cut from the same bar and having identical weight would, naturally, heat and cool at different

Public Service Electric and Gas Co., Burlington Gen. Sta., Dec. 26, 1941. No. 6 Unit—Downcomer Weld. No. 15 Boiler

rates. Disregard of this fundamental point accounts for much of the waste in production of Ordnance equipment by different manufacturers producing the same product from the same metallurgical specifications.

The relation of uniform pyrometer records to uniform products is not generally sensed. There is a difference and a distinction between the temperature at the business end of the pyrometer couple and that of the product itself. Such procedure will lead to development of new standards of quality and uniformity of product; and new forms of heating and cooling equipment for production.

Practical Design of Welded Steel Structures

by H. M. Priest

An up-to-date book of 150 pages copiously illustrated with charts and photos giving practical design information and procedures for the design of welded steel structures. Price $1.00. Bound in cloth covers.

AMERICAN WELDING SOCIETY, 33 West 39th Street, New York 18, N. Y.

Proposed Recommended Practices for Resistance Welding

THERE follows the first two in a series of standards for resistance welding being prepared by the AMERICAN WELDING SOCIETY Resistance Welding Committee. Other standards will include the spot and seam welding of hardenable steels and nickel and nickel alloys. Standards for flash welding and methods of test for resistance welding will also be issued.

The standards presented here have not yet been approved and are published only for the purpose of eliciting comments and suggestions. To be considered, correspondence regarding these standards should be addressed to Secretary, Resistance Welding Committee, AMERICAN WELDING SOCIETY, 33 West 39 St., New York 18, N. Y., so that they arrive not later than September 23, 1944.

1. Recommended Practice for the Spot, Seam and Pulsation Welding of Low-Carbon Steel (Including Coated Steels)

The data submitted herewith have been compiled by canvassing a large number of fabricators of low-carbon steel structures and manufacturers of resistance welding equipment. This information was first issued in June

Low-Carbon Steel Spot Welding Data

THICKNESS OF THINNEST OUTSIDE PIECE "T"	GAUGE	ELECTRODE DIA. AND SHAPE MAX. d	MIN. D	WELD TIME SINGLE IMPULSE (60 PER SEC.)	MINIMUM WELD STRENGTH AND ELECTRODE FORCE: ULT. TENSILE BELOW 70,000 P.S.I. FORCE	STRENGTH	ULT TENSILE 70,000 & ABOVE P.S.I. FORCE	STRENGTH	APPROX. CURRENT	APPROX. DIA. OF FUSED ZONE	MINIMUM WELD SPACING ℄ TO ℄	MINIMUM CONTRACTING OVER—LAP (NOTE 7) L
IN.		IN.	IN.		LB.	LB.	LB	LB.	AMPS.	IN.	IN.	IN.
0.010	32	1/8	3/8	4	200	130	400	180	4000	0.10	1/4	3/8
0.020	26	3/16	3/8	6	300	320	500	440	6500	0.13	3/8	7/16
0.030	22	3/16	3/8	8	400	570	700	800	8000	0.16	1/2	7/16
0.040	20	1/4	1/2	10	500	920	900	1200	9500	0.19	3/4	1/2
0.050	18	1/4	1/2	12	650	1350	---	---	10500	0.22	7/8	9/16
0.060	16	1/4	1/2	14	800	1850	---	---	12000	0.25	1	5/8
0.080	14	5/16	5/8	17	1100	2700	---	---	14000	0.29	1-1/4	11/16
0.094	13	5/16	5/8	20	1300	3450	---	---	15500	0.31	1-1/2	3/4
0.109	12	3/8	5/8	23	1600	4150	---	---	17500	0.32	1-5/8	13/16
0.125	11	3/8	7/8	26	1800	5000	---	---	19000	0.33	1-3/4	7/8

NOTES:

1. TYPE OF STEEL - SAE 1010
2. MATERIAL FREE FROM GREASE, SCALE AND DIRT
3. WELDING CONDITIONS DETERMINED BY THICKNESS OF THINNEST OUTSIDE PIECE "T"
4. DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 4"T"
5. MINIMUM SPACING IS THAT SPACING FOR TWO PIECES FOR WHICH NO SPECIAL PRECAUTIONS NEED BE TAKEN TO COMPENSATE FOR SHUNTED CURRENT EFFECT OF ADJACENT WELDS. FOR 3 PIECES INCREASE SPACING 30 %.
6. ELECTRODE MATERIAL, CLASS II: MINIMUM CONDUCTIVITY - 75 % OF COPPER MINIMUM HARDNESS - 75 ROCKWEL "B"
7.

1943 and since then revisions have been made in the low-carbon steel spot and seam welding data; information on pulsation welding and coated steels has been added. This standardization work was initiated by the Resistance Welding Standards Committee and has been approved by this committee.

Low-Carbon Steel Spot-Welding Data

Electrode Diameter and Shape.—Two forms of electrodes were suggested by several manufacturers; one is the type shown at the top of the column entitled, "Electrode Diameter and Shape." The other was a straight electrode with a dome-type tip with a 2 to 3 in. radius. The latter type now appears to be used more widely.

Several manufacturers do not permit small diameter *d* to exceed the amount indicated in order to control tip contact area. The large diameter *D* is a minimum; in other words, a diameter less than that indicated will result in excessive "mushrooming."

Weld Time.—These values are shown in number of cycles.

Net Electrode Force.—These values refer to the exact force between contact surfaces, such as would be obtained in welding test pieces.

Welding Current.—These values are approximate and are intended to help specify and calculate the capacity of welding machines. They should not be used as exact values to obtain a given weld strength. Current should be increased to obtain proper pull strength just under the metal expulsion point.

Minimum Weld Strength.—A tension-shear test in a reliable testing machine, with the samples unconfined, is the accepted method of checking this value. Weld strengths have been indicated for steel with an ultimate strength below 70,000 psi. and for steel which has been cold worked to ultimate strengths exceeding 70,000 psi.

In considering weld strength, it should be recognized that variations in individual weld strengths exist no matter how accurately the welding variables are controlled. Shop strength, which determines the acceptable machine setting, should therefore be above the minimum value indicated. How much above, should be determined by test and experience; as a guide, it should be set sufficiently above the values indicated so that a negligible percentage of welds will fall below the indicated minimum values when tested.

Diameter of Fused Zone.—These data should be helpful when cross-sectional etch tests are made to check penetration of the weld in the outside thicknesses.

Minimum Weld Spacing.—These values have been tabulated for two thicknesses as explained in footnote 5; the spacing should be increased 30% for three thickness pile-ups in which the shunted current effect is greater.

Low-Carbon Steel Seam Welding Data

The data on this chart are similar to the spot-welding chart. It is intended for pressure-tight seam welding and therefore, indicates welding roll width instead of electrode diameter.

"On times" and "off times" indicate the time during which the current is flowing and interrupted. If a slower welding speed is necessary this should be accomplished by an increase in the "off time," rather than by an increase in the number of welds per inch which would result in excessive heat input and might tax the equipment unnecessarily and cause undue distortion of the work.

A cross-sectional etch test to show the per cent overlap of the fused nuggets (about 20%) and penetration of fused zone in outside thicknesses of metals is the accepted method of testing a seam weld.

Where a seam welder is used for intermittant spot welding the data indicated on the spot welding chart should be used.

Pulsation Welding Data

Because of the lack of complete pulsation welding information the values shown should be used only as a guide. The Committee would appreciate receiving corrections where the values do not appear workable.

Coated Steel Welding Data

Information received from approximately 20 fabricators in coated low-carbon steels indicates that the low-carbon steel chart applies to most of the coated steels with the following exceptions:

Electrode Diameter and Shape.—Dome-type electrode preferred, 2 to 3 in. radius.

Weld Time.—In order to decrease surface burning, 25% reduction in weld time is recommended.

Electrode Force should be increased approximately 25% above values shown to compensate for increased contact resistance.

Welding Current, Approximate Diameter of Fused Zone, Minimum Weld Spacing and *Minimum Contacting Overlap* are approximately as indicated.

These data should be used as a guide in welding:

1. Aluminized steel.
2. Cadmium-plated steel.
3. Chromium-plated steel.

Low-Carbon Steel Seam Welding Data

THICKNESS OF THINNEST OUTSIDE PIECE "T" INCHES	GAGE	ROLL WIDTH & SHAPE d	D	NET ROLL FORCE POUNDS	ON TIME CYCLES (60 PER SECOND)	RECOMMENDED OFF TIME (PRESSURE TIGHT) CYCLES	MAX. WELD SPEED INCHES PER MINUTE	WELDS PER INCH	APPROXIMATE CURRENT AMPERES	MINIMUM OVERLAP * "L" INCHES
0.010	32	3/16	3/8	400	2	1	80	15	8000	3/8
0.020	26	3/16	3/8	550	2	2	75	12	11000	7/16
0.030	22	1/4	1/2	700	3	2	72	10	13000	1/2
0.040	20	1/4	1/2	900	3	3	67	9	15000	1/2
0.050	18	5/16	1/2	1050	4	3	65	8	16500	9/16
0.060	16	5/16	1/2	1200	4	4	63	7	17500	5/8
0.080	14	3/8	3/8	1500	6	5	55	6	19000	11/16
0.094	13	7/16	5/8	1700	7	6	50	5.5	20000	3/4
0.109	12	1/2	3/4	1950	9	6	48	5	21000	13/16
0.125	11	1/2	3/4	2200	11	7	45	4.5	22000	7/8

NOTES:
1. TYPE OF STEEL SAE 1010.
2. MATERIAL FREE FROM GREASE, SCALE, & DIRT.
3. DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 4 "T"
4. THICKNESS OF THINNEST OUTSIDE PIECE "T" DETERMINES WELDING CONDITIONS
5. ROLL MATERIAL:
   MINIMUM CONDUCTIVITY - 75% OF COPPER.
   MINIMUM HARDNESS - 75B ROCKWELL.

FOR LARGE ASSEMBLIES OVERLAP INDICATED SHOULD BE INCREASED 30%

Low-Carbon Steel Pulsation Welding Data

COMBINATION OF THICKNESSES WELDED		RECOMMENDED ELECTRODE DIA. & SHAPE		NET ELECTRODE FORCE	WELDING CURRENT	WELD STRENGTH	APPROXIMATE MINIMUM WELD DIAMETER (FUSED ZONE)	WELD TIME CYCLES (60 PER SEC.) ON TIME OFF 20 CYCLES 5 NUMBER OF PULSATIONS			MINIMUM CONTRACTING OVERLAP SEE (NOTE 4) "L"
T-1 INCHES	T-2 INCHES	MIN. D IN.	MAX. d IN.	LB.	AMPS.	MIN. LB.	INCHES	SINGLE WELD	ADJACENT WELD 2" TO 4"	ADJACENT WELD 1" TO 2"	INCHES
1/8	1/8	1	7/16	1800	18,000	5,000	3/8	3	4	5	7/8
1/8	3/16	1	7/16	1800	18,000	5,000	3/8	3	4	5	7/8
1/8	1/4	1	7/16	1800	18,000	5,000	3/8	3	4	5	7/8
3/16	3/16	1-1/4	1/2	1950	19,500	10,000	9/16	6	14	20	1-1/8
3/16	1/4	1-1/4	1/2	1950	19,500	10,000	9/16	6	14	20	1-1/8
3/16	5/16	1-1/4	1/2	1950	19,500	10,000	9/16	6	14	20	1-1/8
1/4	1/4	1-1/4	9/16	2150	21,500	15,000	3/4	12	18	24	1-3/8
1/4	5/16	1-1/4	9/16	2150	21,500	15,000	3/4	12	18	24	1-3/8
5/16	5/16	1-1/2	5/8	2400	24,000	20,000	7/8	15	23	30	1-1/2

NOTE:
1. TYPE OF STEEL SAE 1010
2. MATERIAL FREE FROM GREASE, SCALE & DIRT
3. ELECTRODE MATERIAL – CLASS II.
   MINIMUM CONDUCTIVITY: 75% OF COPPER
   MINIMUM HARDNESS: 75 ROCKWELL B

4.

4. Copper-coated steel.
5. Lead-coated steel.
6. Nickel-plated steel.
7. Tin-plated steel.
8. Zinc-coated steel.

It is important that electrodes be kept cool by ample water cooling, either external or internal or both, to reduce pickup to a minimum. One fabricator stated that where zinc coating has been removed, as a result of welding, aluminized lacquer should be applied.

Summary

It should be understood that this information should be considered as a guide and representative of the best information available at this time. It is admittedly lacking in time-tested data in the case of pulsation welding and the welding of coated steels. However, revisions will be made when more operating data have been collected.

★ ★ ★ ★ ★

2. Recommended Practice for the Spot and Seam Welding of Stainless Steel

The data submitted herewith on the welding of Stainless Steel have been compiled by a committee composed of prominent fabricators in this metal.

Stainless Steel Spot-Welding Data

Electrode Diameter and Shape.—The dome-type electrode is preferred using the two radii indicated. Diameter D is a minimum, smaller diameters than those indicated will cause excessive "mushrooming" of the welding electrodes. Diameter, d should not be permitted to exceed the values shown in order to control tip contact area.

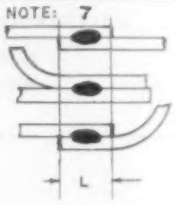
Stainless Steel Spot Welding Data

THICKNESS OF THINNEST OUTSIDE PIECE "T" IN.	GAUGE	ELECTRODE DIAM. AND SHAPE MIN. D IN.	MAX d IN.	R IN.	WELD TIME SINGLE IMPULSE CYCLES (60 PER SEC)	NET ELECTRODE FORCE LB.	MINIMUM WELD STRENGTH ULT. TENSILE 70 TO 150000 P.S.I. LB.	ULT TENSILE 150000 P.S.I. AND ABOVE LB.	APPROX. CURRENT AMPS.	APPROX. DIAM. OF FUSED ZONE IN.	MIN. WELD SPACING ℄ TO ℄ IN.	MIN. CONTACTING OVERLAP (SEE NOTE 7) "L" IN.
.006	38	3/16	3/32	1 1/2	2	180	70	100	3200	.050	3/16	3/16
.008	35	3/16	3/32	1 1/2	3	200	120	170	3500	.064	3/16	3/16
.010	32	3/16	1/8	1 1/2	3	230	180	250	3700	.070	3/16	3/16
.012	30	1/4	1/8	1 1/2	3	260	220	300	4000	.076	1/4	1/4
.014	29	1/4	1/8	1 1/2	4	300	280	380	4200	.082	1/4	1/4
.016	28	1/4	5/32	1 1/2	4	330	330	450	4400	.088	5/16	1/4
.018	27	1/4	5/32	1 1/2	4	380	380	550	4600	.093	5/16	1/4
.020	26	1/4	5/32	1 1/2	4	400	440	600	4800	.100	5/16	5/16
.025	24	3/8	5/32	3	5	520	600	820	5300	.114	7/16	3/8
.030	22	3/8	3/16	3	5	650	800	1060	5800	.130	1/2	3/8
.040	20	3/8	3/16	3	6	900	1200	1650	6700	.160	5/8	7/16
.050	18	1/2	1/4	3	8	1200	1700	2400	7600	.190	3/4	1/2
.060	17	1/2	1/4	3	10	1500	2200	3200	8200	.210	1	5/8
.070	15	5/8	1/4	3	12	1700	2800	4200	9200	.228	1 1/8	5/8
.080	14	5/8	5/16	3	12	2000	3400	5000	9800	.244	1 1/4	11/16
.094	13	5/8	5/16	3	14	2400	4200	6100	10600	.256	1 3/8	3/4
.109	12	5/8	5/16	3	17	2800	5000	7000	11000	.268	1 1/2	13/16
.125	11	7/8	3/8	3	17	3300	5700	8000	11500	.275	2	7/8

NOTES:

1. TYPES OF STEEL 18-8 301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347, & 349.
2. MATERIAL FREE FROM GREASE, SCALE AND DIRT
3. WELDING CONDITIONS DETERMINED BY THICKNESS OF THINNEST OUTSIDE PIECE, "T"
4. DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 4 "T"
5. MINIMUM SPACING IS THAT SPACING FOR 2 PIECES FOR WHICH NO SPECIAL PRECAUTIONS NEED BE TAKEN TO COMPENSATE FOR SHUNTED CURRENT EFFECT OF ADJACENT WELDS.
6. ELECTRODE MATERIAL:
   3/16 & 1/4 DIAM. TIPS – CLASS II MIN. COND. 75% OF COPPER
   MIN. HARDNESS 75 ROCKWELL "B"
   3/8 TO 7/8 DIAM TIPS – CLASS II, III, OR IV

NOTE: 7



Weld Time.—These values are shown in number of cycles.

Net Electrode Force.—These values refer to the exact force between contact surfaces, such as would be obtained in welding test pieces.

Minimum Weld Strength.—A tension-shear test in a reliable testing machine, with the samples unconfined, is the accepted method of checking this value. Weld strengths have been indicated for stainless steel with an ultimate tensile strength between 70,000 and 150,000 psi. (dead soft and 1/4 hard) and 150,000 psi. and above (1/2 hard and full hard). It is recommended that design strengths be 15% below the minimum weld strengths.

In considering weld strength, it should be recognized that variations in individual weld strengths exist no matter how accurately the welding variables are controlled. Shop strength, which determines the acceptable machine setting, should therefore be above the minimum value indicated. How much above should be determined by test and experience; as a guide, it should be set sufficiently above so that a negligible percentage of welds will fall below the indicated minimum values when tested.

Welding Current.—These values are approximate and are intended to help specify and calculate the capacity of welding machines. It should not be used as an exact value to obtain a given weld strength. Current should be increased to obtain proper pull strength—just under the metal expulsion point.

Diameter of Fused Zone.—These data should be helpful when cross-sectional etch tests are made to check penetration of the weld in the outside thicknesses.

Minimum Weld Spacing.—These valves have been tabulated for two thicknesses as explained in footnote 5; the spacing should be increased 30% for three thickness pile-ups in which the shunted current effect is greater.

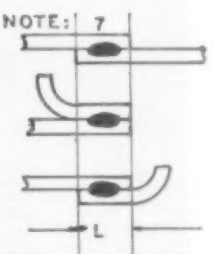
Minimum Contacting Overlap.—These values indicate the required overlap as shown in the sketches below the chart. It is extremely important not to go below the values shown because smaller electrodes must be used.

Stainless Steel Seam Welding Data

THICKNESS OF THINNEST OUTSIDE PIECE "T"		ROLL WIDTH AND SHAPE (R, D, MIN.)		NET ROLL FORCE	ON TIME CYCLES (60 PER SEC)	RECOMMENDED OFF TIME (PRESSURE TIGHT) FOR MAX SPEED CYCLES		MAX WELD SPEED	WELDS PER INCH		APPROXIMATE CURRENT	MINIMUM CONTACTING OVER-LAP "L" (NOTE 7)
IN.	GAUGE	R	D	LB.		2 T	4 T	IN. PER MIN.	2 T	4 T	AMPS.	IN.
.006	38	1 1/2	3/16	300	2	1	1	60	20	18	4000	1/4
.008	35	1 1/2	3/16	350	2	1	2	60	18	16	4600	1/4
.010	32	1 1/2	3/16	400	2	2	2	60	16	14	5000	1/4
.012	30	1 1/2	1/4	450	3	2	2	55	15	13	5600	5/16
.014	29	1 1/2	1/4	500	3	2	3	55	14	13	6200	5/16
.016	28	1 1/2	1/4	600	3	2	3	55	14	12	6700	5/16
.018	27	1 1/2	1/4	650	3	2	3	55	13	12	7300	5/16
.020	26	1 1/2	1/4	700	3	2	3	55	13	11	7900	3/8
.025	24	3	3/8	850	3	2	4	50	12	11	9200	7/16
.030	22	3	3/8	1000	3	3	4	50	12	11	10600	7/16
.040	20	3	3/8	1300	3	4	5	47	11	10	13000	1/2
.050	18	3	1/2	1600	4	4	5	45	10	9	14200	1/2
.060	17	3	1/2	1850	4	5	7	40	10	8	15100	5/8
.070	15	3	5/8	2150	4	5	7	40	9	8	15900	5/8
.080	14	3	5/8	2300	4	6	7	40	9	8	16500	11/16
.094	13	3	5/8	2550	5	5	6	40	9	8	16600	3/4
.109	12	3	3/4	2850	5	7	9	38	8	7	16800	13/16
.125	11	3	3/4	3000	5	6	8	38	8	7	17000	7/8

NOTES:

1. TYPES OF STEEL 18-8 301, 302, 303, 304, 308, 309, 310, 316, 317, 321, 347, & 349.
2. MATERIAL FREE FROM GREASE, SCALE AND DIRT.
3. WELDING CONDITIONS DETERMINED BY THICKNESS OF THINNEST OUTSIDE PIECE, "T"
4. DATA FOR TOTAL THICKNESS OF PILE-UP NOT EXCEEDING 4"T"
5. ROLL MATERIAL CLASS III:
   MINIMUM CONDUCTIVITY 50% OF COPPER
   MINIMUM HARDNESS 95 ROCKWELL "B".
6. WELDING SPEEDS NOT CRITICAL FOR THICKNESSES OF .018" AND UNDER.



FOR LARGE ASSEMBLIES OVERLAP INDICATED SHOULD BE INCREASED 30%

Under these conditions it is difficult to obtain the proper weld strength and under shop conditions the weld strengths are impossible to maintain.

Stainless Steel Seam Welding Data

This information is intended for pressure-tight seam welding. "On times" and "off times" indicate the time during which the current is flowing and interrupted, respectively. If a slower welding speed is necessary this should be accomplished by an increase in the "off time" rather than by an increase in the number of welds per inch which would result in excessive heat input, and might tax the equipment unnecessarily and cause undue distortion of the work.

A cross-sectional etch test to show the per cent overlap of the fused nuggets (about 20%) and penetration of fused zone in outside thicknesses of metals is the accepted method of testing a seam weld.

Where a seam welder is used for intermittent spot welding, the data indicated on the spot welding chart should be used.

Fabrication of Diesel Oil Filters

By A. F. Davis*

MARINE equipment, like items in many other industrial fields, is being produced on a scale that was unheard of a few years ago through the utilization of modern arc-welding techniques and procedures. In designing various parts for welded steel construction, engineers and production specialists have approached their problems open-mindedly, usually changing over one part of a product at a time until the entire structure is as fully welded as possible.

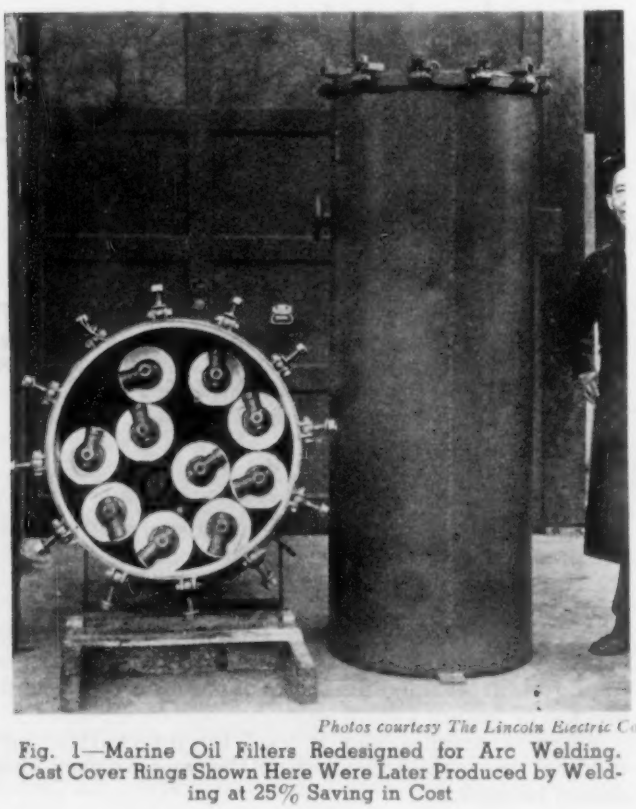
How industry is taking advantage of the fact that steel is 3 to 6 times as strong and $2^1/_2$ times as rigid as similar items of conventional cast iron is typified in a report sent to The Lincoln Electric Company, Cleveland, Ohio, concerning the construction of Diesel oil filters for various types of vessels at the Michiana Products Corp., Michigan City, Ind.

Not only has arc welding speeded up production of this marine equipment, according to the account, but it has reduced the cost of certain assemblies as much as 25%.

Figure 1 shows two of the filters of the larger type which range in sizes of from 40 to 80 in. high with diameters of from 18 to 28 in. Arc-welded steel construction is used throughout.

The component parts of the filter (Fig. 2) clearly show the longitudinal seam which is a square butt joint of $^1/_4$-in. plate. This is welded from both sides, inside, then outside, with no backing and with $^1/_4$-in. electrode for mild steel. The current used is 250 amp.

* Vice-President, The Lincoln Electric Company, Cleveland, Ohio.



Photos courtesy The Lincoln Electric Co.

Fig. 1—Marine Oil Filters Redesigned for Arc Welding. Cast Cover Rings Shown Here Were Later Produced by Welding at 25% Saving in Cost

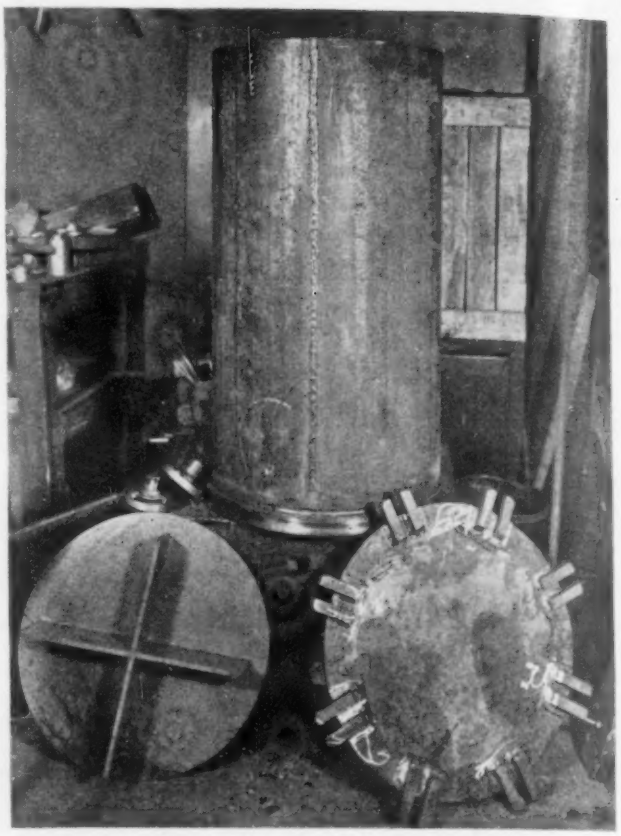


Fig. 2—Filter Parts of Welded Design. Cover Construction Is Shown in Specimens in Foreground

and an arc speed footage per joint of approximately 40 ft. per hour is obtained.

The cover rings shown in Fig. 1 are of the former cast steel construction. The new welded design is made of $1^1/_4$- by $1^1/_2$-in. square stock, cut and rolled into a ring, the joint of the ring veed out and welded with $^3/_{16}$-in. mild steel electrode. The lugs of the rings are stamped out of $^1/_4$-in. plate and welded to the ring from both sides with $^3/_{16}$-in. shielded arc electrode to assure penetration and security. Although the reason for going to the welded ring originally was because of difficulty to get the cast rings, they now find that the welded rings have reduced their cost approximately 25% per ring.

Welding the cover ring to the shell is done with the "Deep-Fillet" procedure. The $^1/_2$-in. thickness of the ring is welded to the $^1/_4$-in. shell with machine set at 300 amp. and obtains an arc speed of 65 ft. per hour.

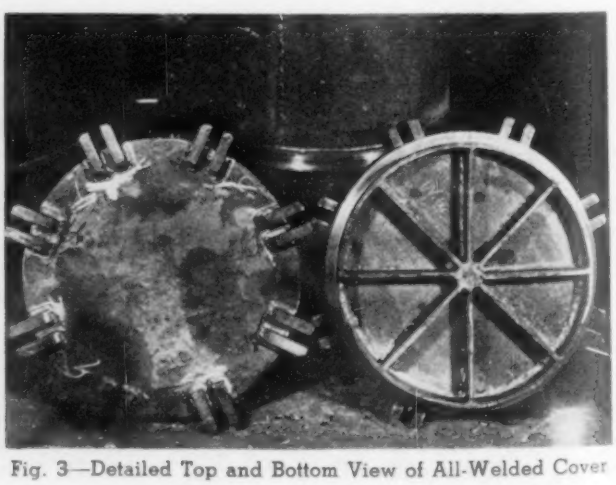


Fig. 3—Detailed Top and Bottom View of All-Welded Cover

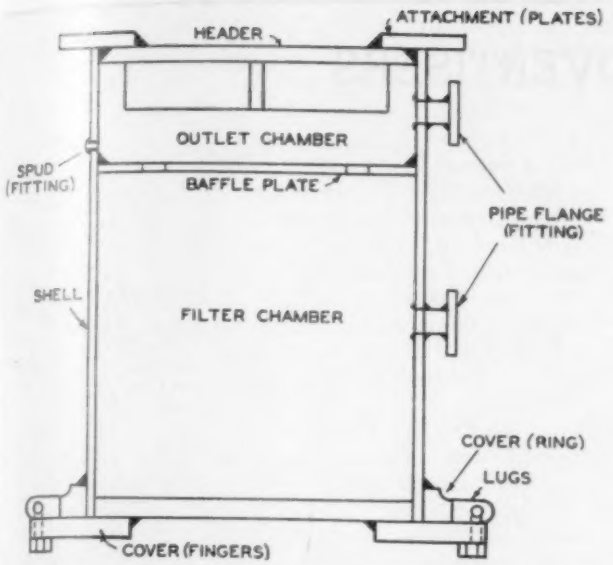


Fig. 4—Cross Section of Oil Filter Showing Location of Various Welds and Component Parts of Structure

The header is $^1/_2$-in. plate with beveled edges. This is welded into the shell with one pass of $^3/_{16}$-in. electrode with a second pass of $^1/_4$ in. size. The arc speed feet of joint per hour is 20 ft. per hour. The attachment plates are $^5/_8$ in. thick, welded on with $^1/_4$-in. electrode and a machine setting of 325 amp. "Deep-Fillet" procedure is also used on this job.

Figure 3 shows the filter cover, which consists of a $^1/_2$-in. plate disk with eight $^3/_8$-in. webs on the inner side, and eight pairs of fingers of $^7/_8$-in. square stock on the outer side. The eight webs are welded one side with the welding continuing around the ring of the cover and hooked 2 in. along the adjacent web. Electrodes for this phase of the work are of $^1/_4$ in. size with machine set at 300 amp. The center boss of the cover is welded to the webs with $^3/_{16}$-in. electrode, and for the fingers on the cover, $^3/_{16}$ in. size is used with an amperage of 225.

Two pipe-flanged fittings are fabricated with $^3/_{16}$-in. electrode and welded in place (see Fig. 4). One spud fitting is also welded into the shell with $^3/_{16}$-in. electrode.

A baffle plate inside the filter (Fig. 4) divides the structure into a filter chamber and outlet chamber. This is $^7/_{16}$-in. plate and is arc welded with mild steel electrode at 300-amp. setting and an arc speed of 65 ft. per hour. Positions of the various welds are also shown in the cross section, Fig. 4.

Excellent results are obtained both from the standpoint of weld quality and appearance, as well as excellent production with the afore-outlined procedures on this job, and the company is very well pleased with the results.

Salvaging Broken Transmission Shifter Forks

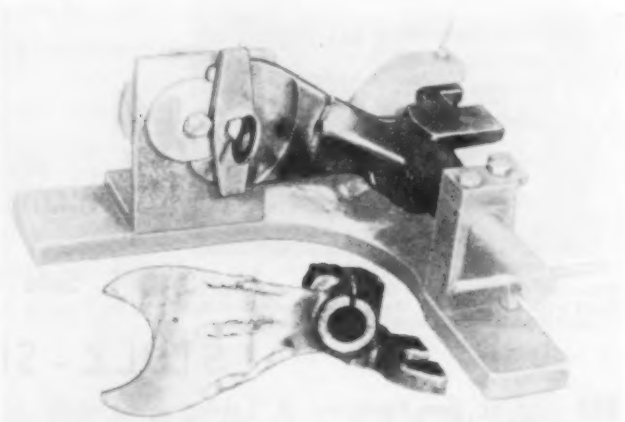
By Clinton Stutter*

WHEN spare parts for seven hundred and fifty trucks of the Department of Sanitation, City of New York, are impossible to get, something has to be done, and quickly. Transmission shifter forks for their four-speed trucks were breaking, and immediately steps were taken for the reclaiming of the broken forks by designing a jig to maintain accurate alignment and spacing during welding of the broken parts.

The jig was built to accommodate both first and second and third and fourth speed forks of one make of truck of which they have seven hundred and fifty. The layout of the jig for welding was made from a new set of forks.

The broken parts are chamfered on a grinding wheel to an approximate 90 V on both faces. In most cases it was found that the metal had stretched from $^1/_{16}$ to $^1/_8$ in. and this extra length had to be ground away. The pieces are then clamped firmly in the jig and the arc welding is done in the usual manner. Where clearance in the transmission allows, a few beads of weld are applied at right angles to the break, these acting as stiffening ribs.

These units are salvaged in groups of four or more forks. Preparation by grinding requires 30 min. for four units, setting in jig and welding take another 30 min., so that with labor cost of $1.40 per hr., power cost of 15¢, welding electrode cost of 0.04¢, overhead of 14¢, a set of four of these forks are being reclaimed for a total cost of $1.73 compared to an original cost of $25 for a set of four new forks, a saving of $23.27 on each lot of four forks.



(*Data and Photos, Courtesy The Hobart Brothers Company.*)

* City of New York.

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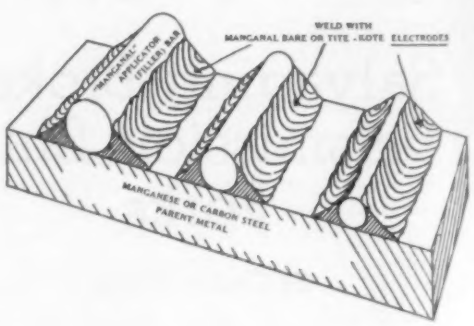

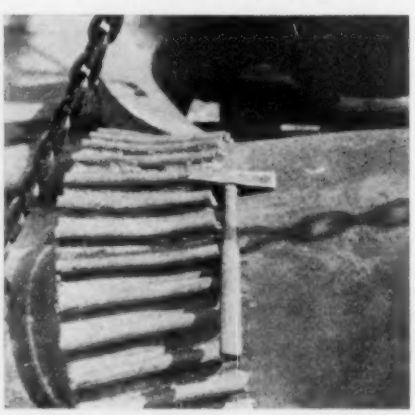

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3 x 3/8" 4 x 1/2" 4" x 1"
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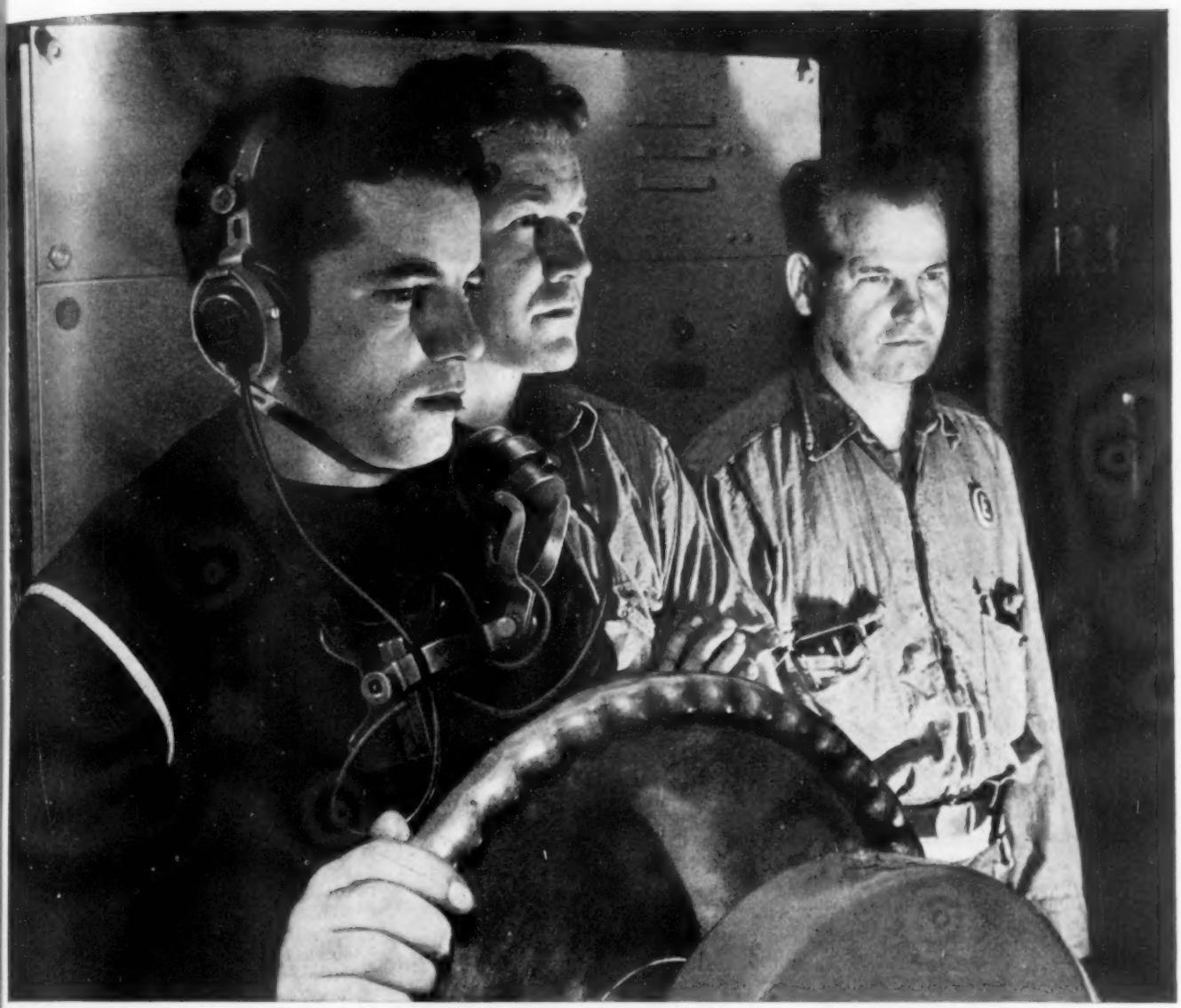

EMERGENCY STEERING STATION on U. S. battleship. The helmsman gets steering instructions over a battle telephone. The two other men are intently watching their gauges.

The Big "Battle Wagons" Are Run by Telephone

There are more than 2000 telephones on just one battleship. And many, many thousands on all the ships in the Navy.

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"GIVE 7 TO 10 TO THE SERVICE MEN"

and help their night-time Long Distance calls from the camps get through quicker to the folks at home.

BELL TELEPHONE SYSTEM

C. A. ADAMS HONORED ON 50TH WEDDING ANNIVERSARY

The 50th wedding anniversary of the Founder and first President of the AMERICAN WELDING SOCIETY, Dr. C. A. Adams, and Mrs. Adams, was celebrated on June 24th at the Maplewood Country Club, Maplewood, N. J. Mr. and Mrs. C. J. Holslag were hosts on this memorable occasion to the celebrants and guests, who included Mrs. Ueberlacker, sister of Dr. Adams, Mr. and Mrs. J. H. Deppeler, Mrs. C. A. McCune, Mr. J. W. Meadowcroft, Miss M. M. Kelly and Mr. and Mrs. A. F. Keogh. Letters of regret at their inability to be present were received from Mr. and Mrs. F. C. Fyke, Dr. and Mrs. H. L. Whittemore, Mr. and Mrs. J. W. Owens, Mr. and Mrs. Wm. Spraragen, Dr. and Mrs. D. S. Jacobus, Mr. and Mrs. H. M. Hobart and Mr. and Mrs. E. H. Ewertz.

The morning and afternoon were given over to golf which was very much enjoyed by all participants. In the evening a most delicious dinner was served in the private dining room, beautifully decorated for the occasion. Mr. Meadowcroft did a creditable job as toastmaster. He talked on the achievements and of the honors bestowed on the "Adams" during these past fifty years. He then called upon the host to say a few words. He next introduced Mr. J. H. Deppeler, second President of the Society, who, in behalf of the hosts and others, presented the celebrants with a plaque on which is to be engraved, in gold leaf, the names of all present. In behalf of the Doctor and herself, Mrs. Adams accepted the gift with sincere appreciation. All present expressed individually their deep feeling of affection and respect for the celebrants.

Dr. Adams then expressed his great pleasure at having his sister and close friends join with Mrs. Adams and himself in celebrating this great event. Dr. Adams attributed his successes in life to the faith, understanding and devotion of his loving wife over the years. He paid tribute also to his devoted sister and he expressed his heartfelt appreciation for the valued friendships acquired since the SOCIETY was founded.

An additional treat was the rendition by Mr. Keogh of a patriotic song entitled "Here's to the Flag," composed by his wife, Edna.

A vote of thanks was given to Mr. and Mrs. Holslag for a most enjoyable day and evening.

BOARD OF DIRECTORS MEETING

The meeting of the Board of Directors held on May 25, 1944, at the Engineering Societies Bldg., 33 W. 39th St., New York, was called to order by President Arnott at 10:15 A.M., with the following present: C. A. Adams, H. C. Boardman, R. W. Clark, J. H. Deppeler, R. S. Donald, O. B. J. Fraser, F. C. Fyke, K. L. Hansen, H. O. Hill, C. H. Jennings, H. W. Lawson, H. W. Pierce, F. L. Plummer, E. R. Seabloom, G. N. Sieger, A. C. Weigel, W. Spraragen and M. M. Kelly.

Finances

Financial Status as of April 30, 1944 compared with April 30, 1943

	1944	1943
Cash in bank	$55,572.53	$42,435.15
Current assets	65,101.38	49,596.31
Current liabilities	3,218.70	1,339.07
Net worth	34,468.52	25,087.32
Excess of income over expense	14,155.92	12,383.25

The Treasurer pointed out that the excess of income over expense shown at the end of April 1944 was due largely to membership gain and increased WELDING JOURNAL advertising and subscriptions.

1944 Annual Meeting Budget

The Treasurer reported that proposed budget of income and expense for the 1944 Annual Meeting, which was submitted with the agenda of this meeting, had been reviewed and accepted by the Convention and Finance Committees and is now offered for the Board's approval.

Upon motion, duly seconded, the 1944 Annual Meeting budget was approved.

A.W.S. Retirement Plan For Its Employees

The Treasurer pointed out that one of the principal differences between the present and proposed regular pension plans is that in the latter the amount of premium to be paid is determined by salary classification, with provision for additional purchases of insurance when the employee changes from one classification to another. The present plan is faulty in this respect. The Treasurer stated that acceptance of this proposal would involve the SOCIETY in an annual expenditure of $3600 per year.

As agreed upon at the meeting the SOCIETY and employees will contribute to this plan in accordance with the following schedule:

Annual Salaries	*Employee*	*Society*	*Total Premium*
Up to $199.99	$ 50	$200	$250
$2000 to $2999.99	75	300	375
$3000 to $3999.99	100	400	500
$4000 to $4999.99	125	500	625
$5000 to $5999.99	150	600	750
$6000 and over	175	700	875

When an employee changes from one premium classification to another due to an increase in salary, a new policy shall be purchased on the ensuing October 1st. In the event of a decrease in salary, the amounts paid by the employee and the SOCIETY shall be frozen at the highest payments in force before the decrease became effective.

Consideration was given to past services.

It was voted to authorize the purchase for each of the four employees having long past service records with the Society, a single payment deferred annuity policy, in accordance with the following formula:

$$\text{Amount of premium} = 85\%\ S \times N \times 10\% - F$$

the total cost of these four policies to be $32,141.

Further, it was voted to authorize the purchase for each of the three employees, with seven years' past service, of additional annuity insurance above the regular schedule, requiring an annual premium payment in accordance with the following formula:

$$\text{Additional annual premium} = \frac{85\%\ S \times N \times 10\% - F}{60 - A}$$

where

S = current salary,
N = number of years of past service,
F = amount paid by the Society into the existing plan,
A = age of employee as of October 1, 1944,

the additional annual cost to the SOCIETY to be of the order of $245. It was agreed not to make mandatory the selection of the insurance company

Special Reserve Fund

In response to inquiry regarding status of our Special Reserve Fund, which is being built up in commemoration of the Society's twenty-fifth anniversary, the Special Reserve Fund Committee Chairman reported that to date only $20,530 has been collected, one contribution being for $1500, seven for over $1000 each, a number for $500 each, and the balance ranging from individual contributions of $300 to $100, with two for less than $100.

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The total represents the result of a single approach in most cases and in others, some follow-up work. Only in a very few cases has there been a definite turn-down. Some have given promise for a later date. In accordance with the wishes of the Board of Directors, the appeal thus far has been made only to Sustaining Members and Sustaining Companies, although an editorial in THE WELDING JOURNAL announcing the drive made mention of the fact that contributions from individual members will be welcome.

The President urged the Board members to assist the Special Reserve Fund Committee in every way possible in attaining the $85,000 goal set, before the end of the current fiscal year.

Recommendations of Outline of Work Committee

Recommendations of the Committee presented by the Chairman of the Outline of Work Committee and the actions taken thereon are recorded below:

Appointments.—(*a*) The appointment of R. E. Cecil, Scaife Co., as designated A.W.S. representative on the National Board of Boiler and Pressure Vessel Inspectors Advisory Committee was approved.

(*b*) It was recalled at the last Executive Committee meeting, Mr. D. H. Corey was designated A.W.S. representative on the Editorial Committee of Heating, Piping and Air Conditioning Contractors National Association, subject to the approval of the Outline of Work Committee. Mr. Clark reported that the Outline of Work Committee had approved this appointment.

(*c*) On recommendation of the Outline of Work Committee, Messrs. J. H. Blankenbuehler, Westinghouse Electric & Mfg. Co., and J. W. Sheffer, American Car & Foundry Co., were continued as A.W.S. representatives on A.S.A. Sectional Committee C52—Electric Welding Apparatus, and S. A. Greenberg, Acting Technical Secretary of A.W.S., was designated to replace L. M. Dalcher on this Committee.

Tentative Weldability Tests for Alternate Aircraft Steels.—Upon recommendation of the Outline of Work Committee, Tentative Weldability Tests for Alternate Aircraft Steels, as published in the February 1944 WELDING JOURNAL, were approved for publication as a tentative standard of A.W.S.

Amendment of Rules Governing Technical Committees.—On recommendation of the Outline of Work Committee, the following additions under general instructions of Guide for the Appointment and Functioning of Representatives of the AMERICAN WELDING SOCIETY on Technical Committees of Other Societies, was approved:

"Where more than one representative is designated on a Committee, a Chairman shall be chosen by the representatives and he shall be required to render the annual report."

Revised Rules for Fusion Welding Piping in Marine Construction.—On request of the Outline of Work Committee, the Board of Directors considered the endorsement, as a standard of the SOCIETY, of Rules for Fusion Welding Piping in Marine Construction, prepared by the Subcommittee on Machinery Construction of Committee on Welding in Marine Construction, and approved by that Committee.

On recommendation of the Outline of Work Committee, it was voted that Revised Rules for Fusion Welding Piping in Marine Construction, with a suggested slight modification, be approved subject to the endorsement of suggested modification by the committees concerned.

Coordinating Committee on Research.—It was voted to authorize the appointment by the President of a Coordinating Committee on Research, with scope and personnel as given below:

Scope: (1) To develop research problems, as needed, for the furtherance of A.W.S. Standardization activities. (2) To submit programs of research on these problems to the Welding Research Council. (3) To interpret the data thus obtained, as it was developed, for use by the Technical Committees.

Personnel: H. O. Hill, *Chairman*, S. A. Greenberg, *Secretary*, L. C. Bibber, T. R. Higgins, G. S. Mikhalapov.

NOTE! In accordance with action taken at the March 15th Executive Committee meeting, W.R.C. will be informed of the above action and requested to accept this Committee as the A.W.S. Advisory Committee.

(*Continued on page 724*)

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Electric Welding, Power Supply. Capacitor-Discharge Welding

(*Continued on page 730*)

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(*Continued from page 784*)

Relocation of Indiana and Louisville Sections

Because of the geographical locations of the two Sections in question, the Section Advisory Committee Chairman reported that it had been proposed that they be located in District No. 5, rather than No. 4, as originally located in the Districts approved by the Board of Directors in October 1943. Both Sections and the Vice-Presidents of Districts Nos. 4 and 5 have approved of this relocation and the Sections have unofficially been operating in District No. 5 during the past season.

On recommendation of the Section Advisory Committee, the relocation of the Indiana and Louisville Sections from District No. 4 to District No. 5 was approved.

Engineering Foundation Grant to Welding Research Council

On request of W.R.C., a communication was addressed to The Engineering Foundation endorsing W.R.C.'s application to The Engineering Foundation for the continuance of support of the work of the Council in an amount of $4000, for the year 1944–45.

Upon motion, duly seconded, endorsement of request for the continuance of The Engineering Foundation support of W.R.C.'s work was approved.

Cooperation with American Foundrymen's Association in Bringing Foundrymen to a Greater Realization of the Possibility of Welding.

It was voted to request the Outline of Work Committee to give immediate consideration to the appointment of a joint committee of A.F.A. and A.W.S., with scope to develop suitable procedure for the repair by welding of gray iron castings and, further, that the findings of this committee be offered in the form of a paper for presentation at the Annual Meetings of the A.F.A. and of A.W.S.

Also, the Board favored the A.W.S. Program Committee assisting, in so far as possible, the A.F.A.'s Program Committee in securing papers and speakers for the Annual Meeting of that Society on the subject mentioned, and it further favored consideration by the A.W.S. Program Committee to staging a session on the subject on the Annual Meeting program of A.W.S. to which the A.F.A. membership ought to be invited.

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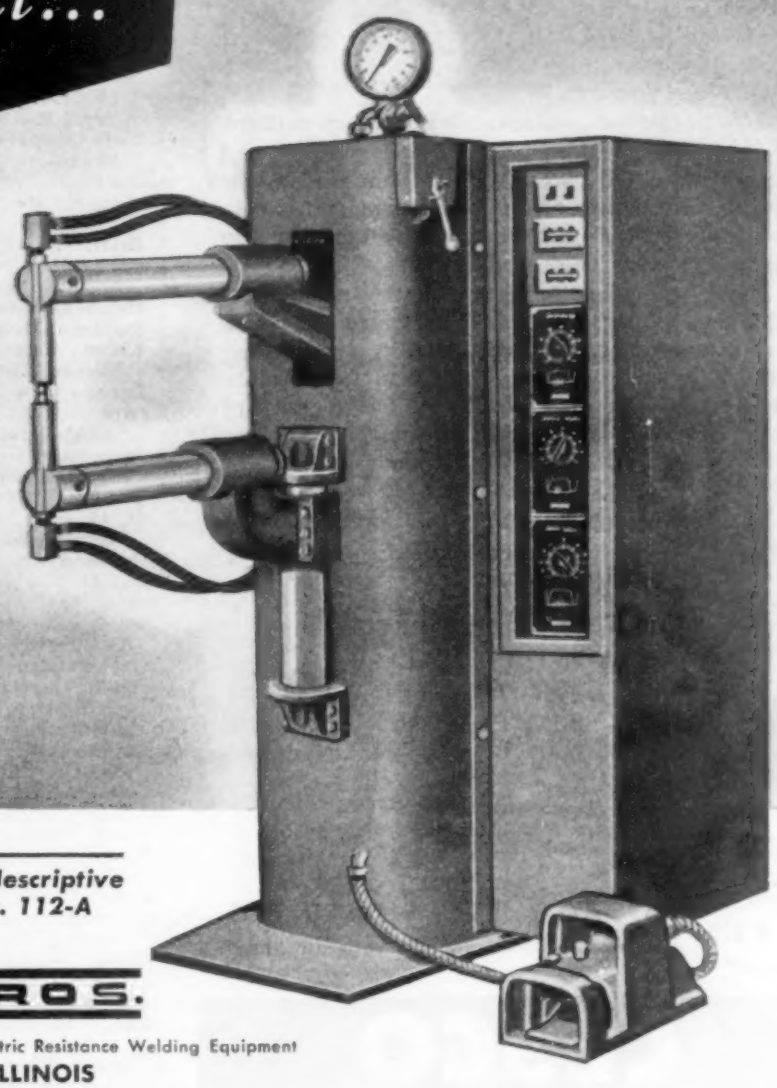

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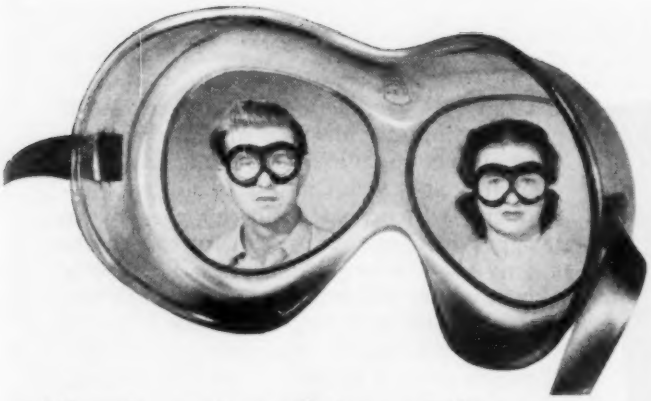

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No need to "do without"— Bronze Welding is Industry's No. 1 Tool for Salvaging Worn Parts

For building-up worn surfaces or making repairs to cast iron, malleable iron, steel or copper alloy parts, there's nothing so economical and dependable as Bronze Welding. That large bearing, for instance: It was worn out giving years of service on a nail making machine. Replacement from stock was impossible, yet the manufacturer just couldn't "do without." Built up with strong, tough, dense-grained Anaconda Manganese Bronze Welding Rod and machined, the bearing was quickly returned to service.

Or that 5,000 hp. turbine runner: Stones and gravel brought in with ice in the Spring badly damaged some of the buckets while others were broken off completely. Again Bronze Welding was used to build up the worn surfaces and weld in new patches. The cost, compared with that of a new runner, was negligible.

Maintenance men everywhere are taking advantage of the salvage and repair opportunities made possible with the oxy-acetylene torch and such rods as "997" Low Fuming, Tobin Bronze* and other Anaconda Welding Rods. Applications of these rods are described in Anaconda Publication B-13. Write for a copy.

*Reg. U. S. Pat. Off.

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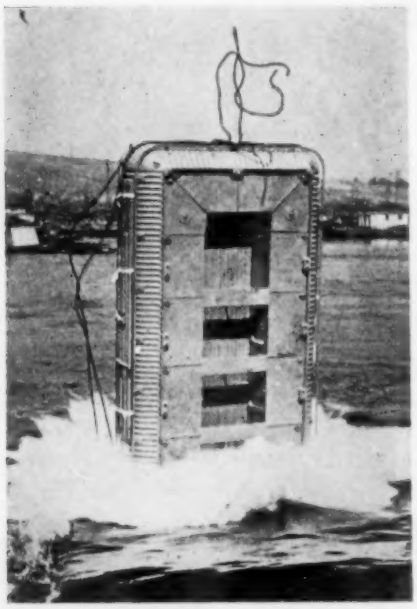
METAL LIFE RAFTS

On metal life rafts, built by Weber Showcase Co., Los Angeles, Calif., there are 48 manganese bronze drain flanges joined to the 1020 steel sections from which the raft is made. Bronze welding these flanges in place proved a slow method, taking 7 to 12 min. per flange. In working out a production setup for doing this job, the company, after thorough experiment and tests, developed a method of application using the low-temperature silver brazing alloy Easy-Flo and induction heating, which together reduced joining time to 51 sec. per flange. What had been a serious bottleneck in constructing the rafts became the fastest part of the assembly. After proper cleaning and fluxing, a washer of Easy-Flo 0.003 in. thick is preplaced between the flange and a raft section. An operator and a helper complete strong, leaktight joints in less than a minute which hold firmly in place through every drop test the raft is required to meet.



Drop-Off Tests Demonstrate the Sturdy Weber-Built Rafts Can Withstand the Battering They Will Receive When Launched from a Stricken Cargo Vessel or Oil Tanker. Here One Smashes Into the Water on End, from Height of 45 Ft. Prototype Was Dropped Three Times, on End, Side and Flat, Without Damage

WELDING DISTRIBUTORS ASSOCIATION

The formation of the Welding Distributors Association was announced in a recent issue of THE WELDING JOURNAL.

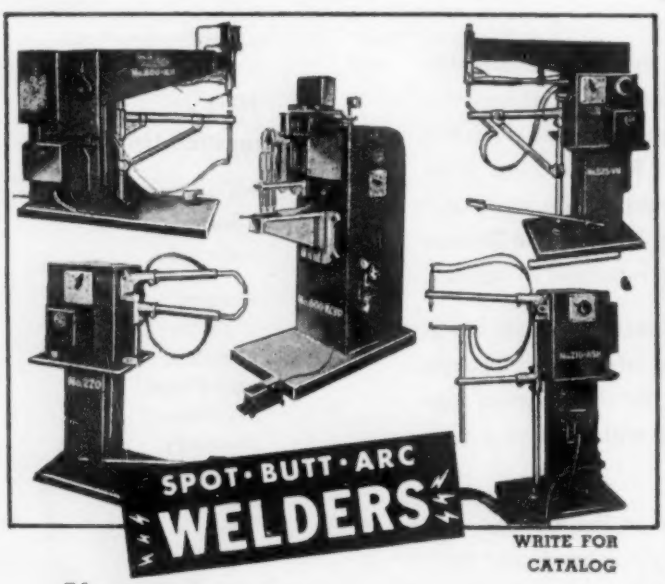
The association was formed to promote the increased use of welding equipment and supplies, and to perform such additional cooperative and coordinating services as it may to further the general development and improvement of the industry.

Additional functions are: (*a*) to inform the consuming trade and others of the benefits derived by their purchases through dealers of welding equipment and supplies; (*b*) to inform the welding equipment and supply manufacturers of the requirements of the trade; (*c*) to collect, compile and disseminate statistics and information beneficial to its members.

Mr. Allan W. Gordon has been appointed executive secretary of the Welding Distributors Association, the new address of which is 494 Arcade Bldg., St. Louis 1, Mo.

MOGUL NERVOUS WELD BULLETIN

A new 4-page bulletin gives complete information on the new Mogul Nervous Weld Process which now makes possible for the first time a positive method of salvaging of defective aluminum castings. Bronze, grey iron, malleable and steel castings can also be effectively reclaimed by this amazing process. Contains description of new Mogul Nervous Weld Pistol and Machine, also prices for complete installation. In addition other time- and money-saving applications possible with this remarkable new unit are described, including such important uses as plugging holes, building up shrinkage fissures, changing the contours on moulds and building up dimensional surfaces on parts that have not cleared up properly. Write Metallizing Co. of America, 1330 West Congress St., Chicago, Ill.



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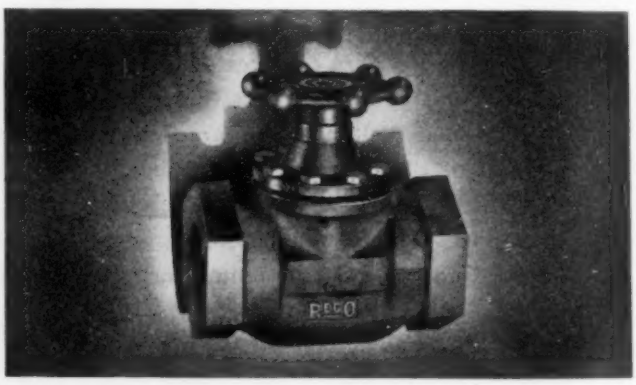

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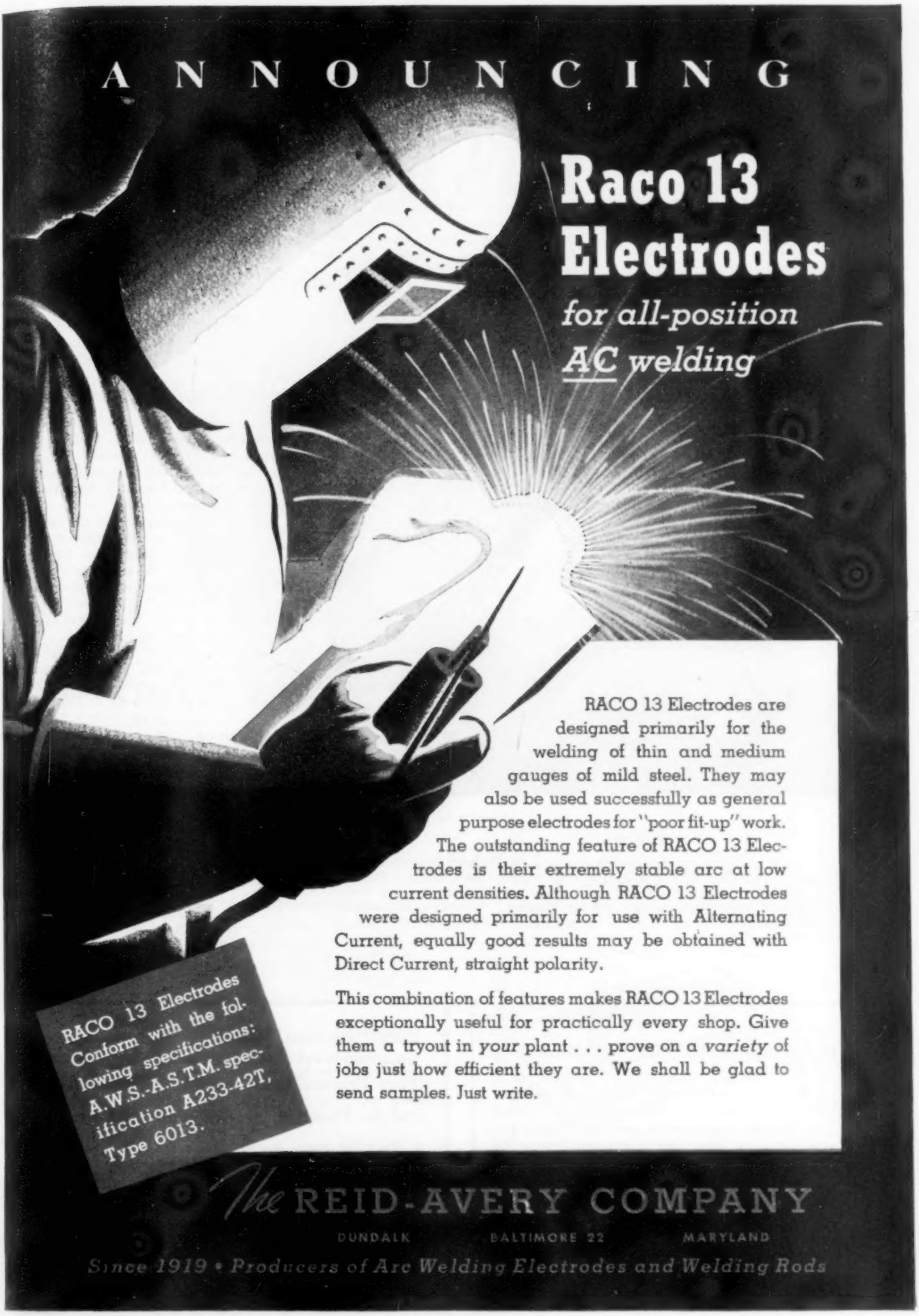
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UNITED WELDING ENLARGES ITS ENGINEERING STAFF

Paul H. Setzler has joined the engineering staff of The United Welding Company, Middletown, Ohio, as consulting engineer. He brings with him an engineering background in the field of welding that covers many years. For four years he was development engineer at Lincoln Electric and for the seven years preceding he was production manager at Lukenweld, Inc.

United Welding have specialized on fabricated welding since 1913 and today serve many industries, prominent among them the machine tool builders and the paper industry.

Mr. Setzler is available on call to companies interested in welding all or parts of the products they now build or plan to build after the war.

TAMPA SHIPBUILDING CO., INC.

Tampa Shipbuilding Co., Inc. of Tampa, Fla., has been awarded the Army-Navy "E" for excellence in building ships for the United States Navy. James Forrestal, Secretary of the Navy, so notified George B. Howell, Tasco president in a letter recently.

Tasco was organized by Howell in November 1940, and expanded within a 25-mo. period from a Yard with 300 employees to a complete shipbuilding plant employing more than 15,000. While going through this expansion the Yard continued to build and launch ships on schedule and to date has launched 51 vessels of five different types ranging from the huge destroyer tenders to the streamlined mine sweepers.

ACKNOWLEDGMENT

By Milton Forman

In an article published in the May 1944 issue of THE WELDING JOURNAL on the subject of Welding Sequence in Shipbuilding the author described the welding procedure in sequence used by the Toledo Shipbuilding Co. under the direction of the writer. Inadvertently, the author forgot to make suitable acknowledgment of the pioneer work by Walter J. Thomas, Welding Engineer of Los Angeles, Calif., who was originally responsible for the development of these procedures and sequences so successfully followed under the author's direction at the Toledo Shipbuilding Co.

Courtesy The Lincoln Electric Co.

Earth Moving

The yoke, not of oxen but of a giant earthmover, frames others at work leveling hills in Iceland. The electric arc welded construction of these big machines is virtually the standard method of construction for military equipment of all kinds. It is an example of modern-day methods, as far advanced over oxen-day methods of moving earth, as the earthmovers which are giving American troops an edge in every theater of war.

AMPCO BUILDS WEST COAST PLANT

In order to improve delivery and technical advisory service to West Coast customers, Ampco Metal, Inc., Milwaukee 4, Wis., has built and completely equipped a new plant at 30 East Burbank Blvd., Burbank, Calif.

West Coast activities of the company will henceforth be concentrated at the Burbank works. Customers who have been dealing with the company's previous West Coast manufacturing facilities, which were the Hollywood Aluminum Products Division of Ampco Metal, will find the same personnel at Burbank. Works Manager is Mr. E. H. Wilson; Plant Superintendent, Mr. P. P. Bergmann. Field Service Engineer is Mr. O. D. Cooper, assisted by Mr. L. C. Dean.

ARCLESS CURRENT INTERRUPTION

A reprint of an article by Charles W. Dodge, John S. Stamm and Nelson W. Spencer, on "Arcless Current Interruption in Inductive D-C Circuits," printed in the March 1944 issue of THE WELDING JOURNAL, is available on request by writing to Sciaky Bros., 4915 West 67th St., Chicago 38, Ill.

TECHNICAL EDITOR OR MANAGER

wanted by group of manufacturers, capable of preparing technical bulletins, revising and editing textbooks relating to Resistance Welding and handling publicity. Duties also involve preparation of standards and specifications for Resistance Welding Machines, cooperative activities with other groups, speaking before technical societies, etc. Should live in Philadelphia, Pa., and spend some time traveling. Give full details regarding qualifications, past experience in Industry, educational background, and salary desired. Apply to Resistance Welding Manufacturers' Association, 505 Arch Street, Philadelphia 6, Pa.

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ARC-WELDED TRUCK FRAME FOR PENDULUM TYPE RAIL CAR*

The subject matter of the ensuing article concerns itself with the fabrication, by the electric arc welding process, of a distinctive type of rail car truck frame to be used under a nonconventional type of passenger-carrying rail car, generally referred to as the pendulum type car. Four of these truck frames were built for two leading American railroads and the subject matter is gathered from the fabrication of these four original frames. The writer understands some additional units have since been built.

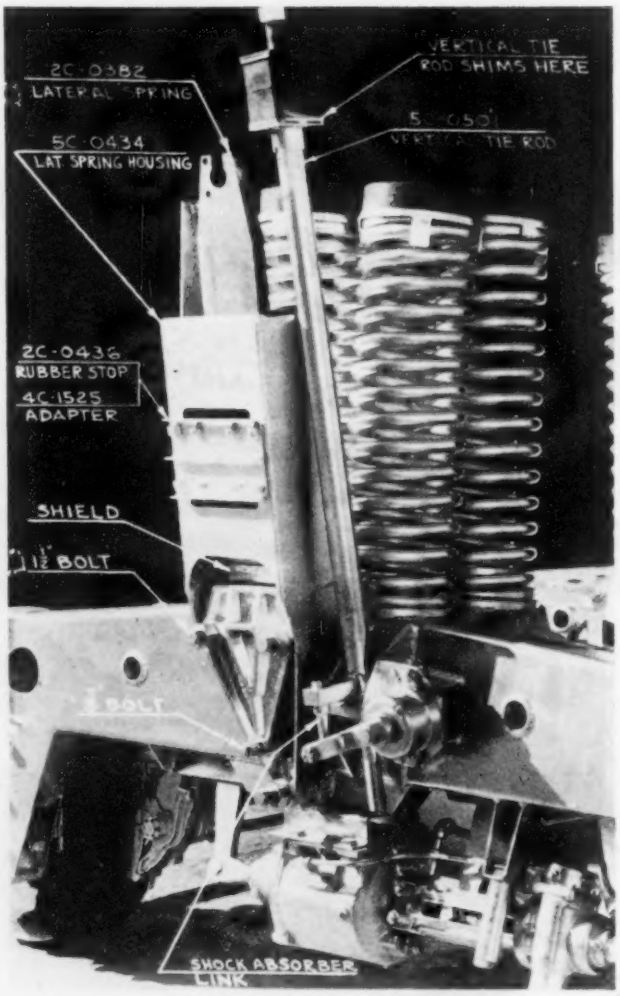
The design of this new type rail car obviously called for a distinctive design of truck frame as shown in the accompanying illustration, one in which such commonly needed parts as center plates, swing hangers, side bearings, truck bolsters, spring planks, etc., would be missing from the trucks.

The Fabrication

There was nothing unusual in the methods used in the fabrication of these truck frames. Owing to the limited number of them being built, no main assembly jig was used in their construction. In fact, the fabricating company built them much like a connoisseur of fine furniture might build a replica of some old masterpiece endeavoring to get every dimension, joint, detail and finish just as the designer visioned it. The numerous plates were sized and formed, their edges scarfed and ground, and along with the castings delivered to a fit-up table where a mechanic and his helper, outfitted with a flame cutting torch, hammer, square, plumb bob, level, and a few fit-up bolts, went to work.

The work progressed by the smaller plates being fitted up from detailed drawings, arc tacked, passed to the welder and back to the fit-up table; this cycle being repeated until the truck frame had grown into three main assemblies: (1) right side rail; (2) left side rail; (3) center box assembly. These three assemblies were then welded together to make the final assembly, fillets for contour welded in the high stressed areas, steel tubing welded through and to the side rail ends, the pedestals and various appointments attached to the structure.

* From a paper submitted by Harold A. Patterson, Inspector, Car Construction Engineering Dept., A. T. & S. F. Railway Co., Topeka, Kans., in the Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.



Side View of All-Welded Pendulum Car Truck Frame

The job now went over the straightening jig, into the heat-treating furnace, back over the straightening jig to the magna-flux corner, to the sandblasting room, to the inspection table, to the paint shop, and then on its way to the car builder.

The Welding

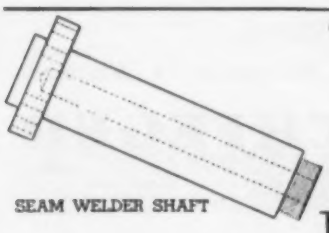
The arc welding on these truck frames was all performed by hand welding, no automatic devices of any kind being used, and I believe that everyone who shared in the responsibility of this job felt that only the best quality of welding obtainable was good enough, and while elapsed time and cost were a necessary objective, they were not the most essential objective, so the welders who were assigned to this job were picked and all Navy certified. This assured us that we had the basic welding skill to properly carry on the job.

The next step was to have the welders make a series of test specimens, using coupons cut from the various heats from which the frames would be built. These specimens were made up in type of joints that would be typical of those found in the truck frames such as single-V butt joint, single-V butt joint reinforced, lap joint, square tee fillet joint, inside fillet joint, etc. These various specimens were made both parallel and transverse to the steel rolling, and in both the heat-treated and as-welded condition, and shipped to the test laboratory of one of the interested railroads, and after these specimens had been tested to the satisfaction of the railroad engineers, the welding got under way.

Aside from the constant inspection of both the railroad and fabricating company's inspectors, the help of both the X-ray and magna-flux machines were employed. The Navy standard of acceptance was used. Some radiographs were made at random on the welded seams and some where the railroad inspector might suspect a bad condition.

After the various butt-welded seams had been completed, every inch of these seams was magna-fluxed.

The welders assigned to this job were all equipped with a pneumatic scaling tool and wire brush and every welding pass was scaled and brushed. Almost all the butt-welded seams were reinforced, and in this article the writer defines the reinforced seam as one that has the weld root chipped until all visible scale, slag, craters, gas pockets, or unfused portion of the base metal have been removed, this channel then welded, the result being a clean, sound, double-V butt joint. In seams where it was not possible to reinforce, a steel backing strip was placed at the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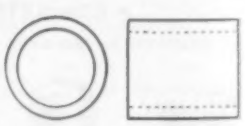
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weld root, this strip becoming an integral part of the assembly.

The welding rod used was of the heavy-coated type, one approved for high-tensile cromansil plate. This rod was of a type welders often refer to as a hot rod. The welding was all positioned, all work being executed in the down-hand position. A standard type of rotating welding jig was used on small assemblies and when the assembly grew too large, it was placed on the floor and chain hoists or the shop crane used to position it.

An interesting development on this job in using the X-ray and magna-flux was that, while they both disclosed conditions in the weld seams that called for correction, the major defects that they disclosed were not in the weld seams or in the structural plate, but in the side rail castings.

Conclusion

As has been previously outlined, due to the experimental and pioneering aspect of this job, the writer does not make any claim of a favorable unit cost comparable to one now secured on the conventional cast-steel type of truck frame, but from an accumulated experience on these truck frames and other welded assemblies and from the performance of these truck frames in actual service, I am convinced that, applying this built-up-arc welded type of construction to the conventional type of truck frame as used under passenger-carrying rail cars and certain types of locomotives, the builders could obtain at least a 15% reduction in weight at a 10% reduction in cost and deliver a better, finer finished product that would pay the ultimate consumer dividends throughout its life in maintenance, cost and fuel consumption. It is estimated that in a normal year one thousand of these units could be absorbed in this country.

STEEL FOUNDRY WELDING

Air Reduction, producer of welding equipment and supplies, is now distributing a new 32-page booklet, "New and Improved Oxyacetylene Methods for Steel Foundries." Profusely illustrated, the booklet, as its name implies, describes numerous new and improved methods of performing common steel foundry operations by the use of the oxyacetylene flame.

Principal stress among the methods described is laid on the removal of risers by machine flame cutting. A number of examples of this practice are illustrated and comparisons are drawn with the hand torch method of riser removal.

Other processes treated in the booklet include: flame scarfing to remove pads left after riser removal; flame gouging for the removal of webs, fins and defects; flame descaling for cleaning normalized or annealed castings; flame lancing and its various uses in the steel foundry, and flame hardening for the localized hardening of steel castings. In a number of instances, actual comparisons with former methods of performing the work show important economies effected by the processes described.

Also included in the booklet is a section describing and illustrating equipment recommended for the various processes.

Copies of the booklet may be obtained from Air Reduction sales offices located in principal cities or by addressing Air Reduction, 60 East 42nd St., New York 17, N. Y.

SELECTIVE COPPER BRAZING

Selective copper brazing of an ordnance part on a high production basis yet without the high scrap percentage of conventional brazing methods has been developed at the Industrial Steel Treating Co. of Jackson, Mich., and is in production there at the present time.

The process employs electric salt bath furnaces which not only permits the selective heating of the parts to be brazed, but also eliminates decarburization, and has reduced scrap from 15% to a maximum of 3% as compared with conventional methods. The salt bath furnace method has also reduced distortion so that the amount of time and cost involved in straightening brazed work has become negligible. As a result, what was once considered a difficult, "tricky" job has now taken its place as a simple, foolproof production heat-treating operation with results that are completely predictable.

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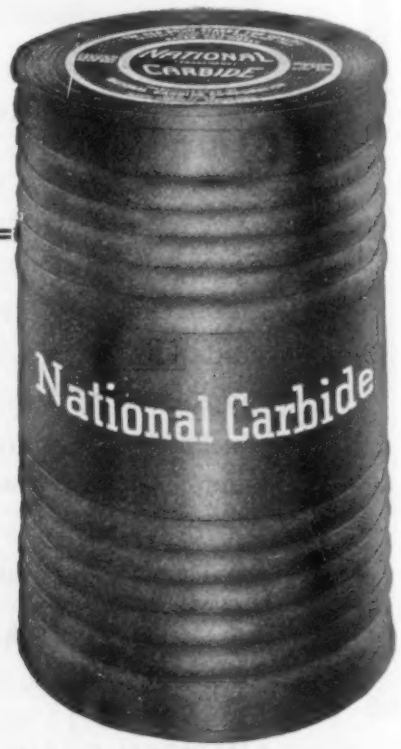

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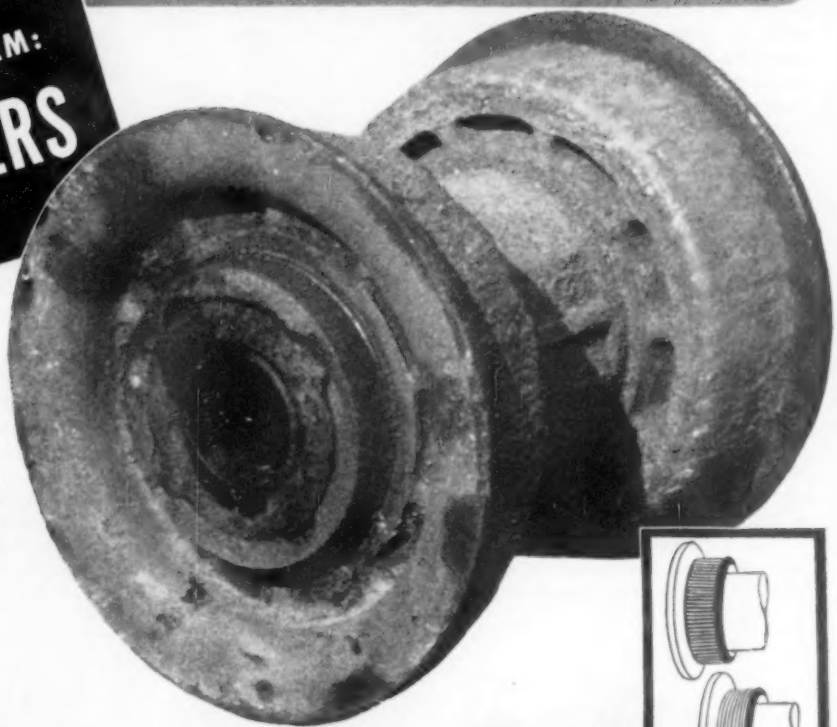
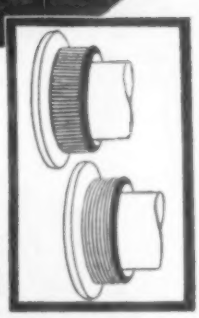
THIS MONTH'S WEAR PROBLEM: TRACTOR ROLLERS



SELECTING the proper hardfacing alloy for any job must always be based upon operating conditions, which vary infinitely between applications. Tractor Rollers, for example, must withstand:

IMPACT of rails against rollers.
ABRASION of earth between metal parts.

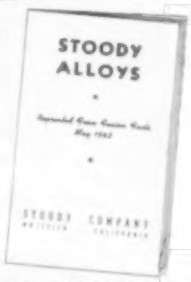


STOODY SELF-HARDENING is the pick of the 12 Stoody alloys for hardfacing tractor rollers. It's tough enough to take the jarring impact of heavy rails on the rollers without chipping or spalling, and the high-alloy content provides the extra wear resistance to combat earth abrasion. Wear resistance is so great, in fact, tractor rollers hard-faced with Stoody Self-Hardening outwear by two to one the best high carbon that can be applied! Because of Stoody Self-Hardening's low coefficient of friction, actually less wear occurs between roller and rails than with steel-to-steel contact.

In addition, Stoody Self-Hardening is easy and fast to apply, is very dense and can be readily peened to shape. An expert welder can apply this alloy so smoothly that grinding after hardfacing is unnecessary.

HARD-FACING PROCEDURE:

Stoody Self-Hardening can be applied to tractor rollers either of two ways: (1) A bead run around the outer edge and space between the bead and collar filled in with horizontal welds or (2) A bead around the outer edge to bring the roller back to diameter, and intervening area between outer edge and collar filled with a series of circumferential beads of hard metal. Either method is equally successful but the latter has the advantage of more easily maintaining roller concentricity. Rollers with integral bearing assemblies are best hardfaced immersed in a tank with circulating water to keep bearings cool.



To resist all types of metal wear under any set of conditions, Stoody alloys are made in a dozen different analyses. Each hard-facing rod has its own definite characteristics and is recommended for specific applications. OUR FOLDER "Stoody Alloys" explains the sizes, styles and properties of each rod and lists several hundred tested applications in 17 industries. A copy is yours for the asking. Write today.

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STOODY HARD-FACING ALLOYS
Retard wear . . . Save Repair

The operation consists of copper brazing two small cheek plates to a length of 1050 steel. The plates, of approximately one inch square area and but $^1/_8$ in. thickness, are first tack welded (by spot welder) to the sides of the strip, the copper shim being inserted prior to the welding. The parts are then placed in a rack which holds 20 pieces thereby affording easy manual handling.

Three standard electrically heated salt bath furnaces are employed: preheat, high heat and quench. The temperatures of the furnaces are controlled automatically to close limits with special timing controls. The control for the high heat furnace holds the temperature of the furnace at a constant level until work is to be treated. Then, a special heat measuring control on the instrument panel permits the operator to add exactly the required amount of heat for the exact predetermined time. Thus, the operation is entirely automatic with temperatures and time being fully controlled.

POSITION WELDING BULLETIN

Information on position welding and a description of the complete Ransome line of welding positioning equipment is featured in a 40-page, two-color bulletin, No. 2151, released by Ransome Machinery Co., Dunnellen, N. J., a subsidiary of Worthington Pump and Machinery Corp.

This bulletin treats the many advantages of proper positioning for welding and fully explains the use of positioning equipment with pictures and text. The complete range of Ransome Positioners from a small hand-operated unit to the 40,000-lb. heavy-duty machine are illustrated, as are Turning Rolls and Headstock-Tailstock combinations. Dimensions, load capacities and complete specifications on each model are included. A good selection of installation photographs showing various models in diversified use are scattered throughout the book. Special applications and special Assembly and Welding Fixtures are included. A copy of Bulletin No. 2151 may be had by addressing the company.

HOBART ISSUES FIRST VOLUME OF WELDING DESIGN PLATES

"Practical Design for Arc Welding," Vol. 1, by Robert E. Kinkead, Consulting Engineer, Welding; 100 design plates, cloth bound, $8^3/_4$ x $11^1/_2$ in., published by The Hobart Brothers Co., Hobart Square, Troy 1, Ohio. Price $3.50 per volume; complete 3-volume set, $10.

This is the first of three volumes to be published by The Hobart Brothers Co. in response to many requests, following the original publication and distribution of a number of the design plates in loose-leaf form.

A practical working book for the welder, manufacturer, engineer and designer who are working and thinking of the advantages of arc welding in their present and postwar production. It is not a text-

book, but an illustrated storehouse of information and detailed drawings showing how tubing, plate, sheet, standard steel sections, angles and bars can be used to fabricate better, stronger, improved appearing products with arc welding and do it at substantially lower cost.

To make this book valuable as well as practical from a reference and design standpoint, a complete work sheet in graph form is shown opposite each design plate. On these work sheets can be made notes, estimates and sketches as the design plate relates to the projected design. Important, too, is the Record form provided on the working sheet, that can be used to suggest and analyze applications of design ideas to the user's own products.

SERVICE ON FABRICATED WELDMENTS

Parts up to many tons welded and shipped with dispatch from private rail siding. Thousands of tons of diesel engine frames alone fabricated for war program.

Specialists in styling of machine tool bases, frames and housings. Submit your drawings. Difficult assignments particularly invited. No obligation.

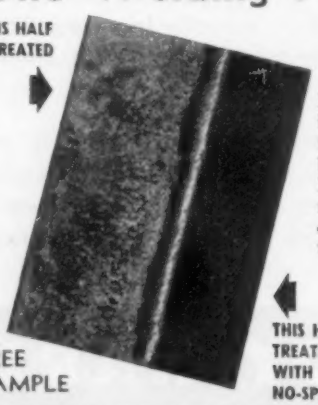
THE UNITED WELDING CO.
MIDDLETOWN, OHIO

UNITED WELDING
WELDING FABRICATORS OF MODERN DESIGNS

Save Time and Labor Costs:
Cut Down Fumes 30%:
Protect Metal Against Rust:
Get Unimpaired Welding Strength:
Do Cleaner Better Work—with

NO-SPAT

The Welding Fluid that Is Non-Toxic

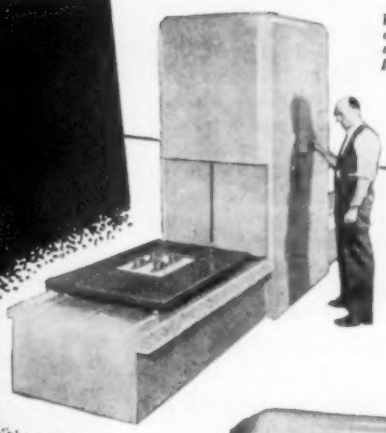


NO-SPAT prevents welding spatter from adhering to metal surfaces—Unbiased scientific tests show NO-SPAT maintains maximum weld strength—reduces fumes 30%, is non-toxic—does not produce carbon monoxide.

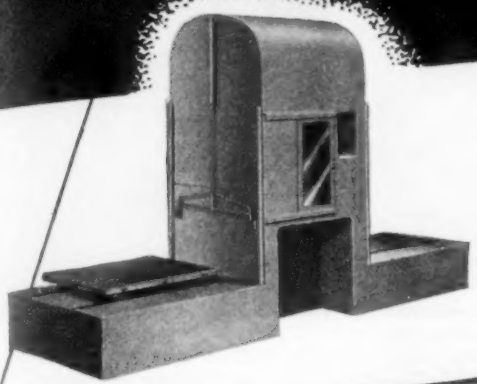
NO-SPAT requires no mixing — apply and start welding at once. No time wasted.

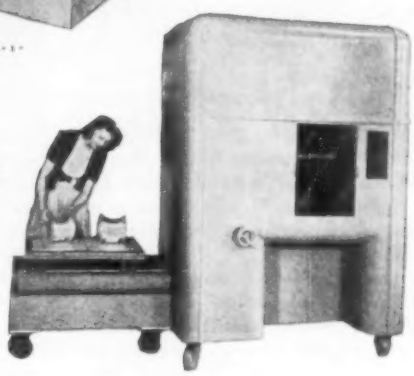
THE MIDLAND PAINT & VARNISH CO.
9126 RENO AVENUE CLEVELAND 5, OHIO

KELEKET X-RAY CAN IMPROVE YOUR PRODUCT



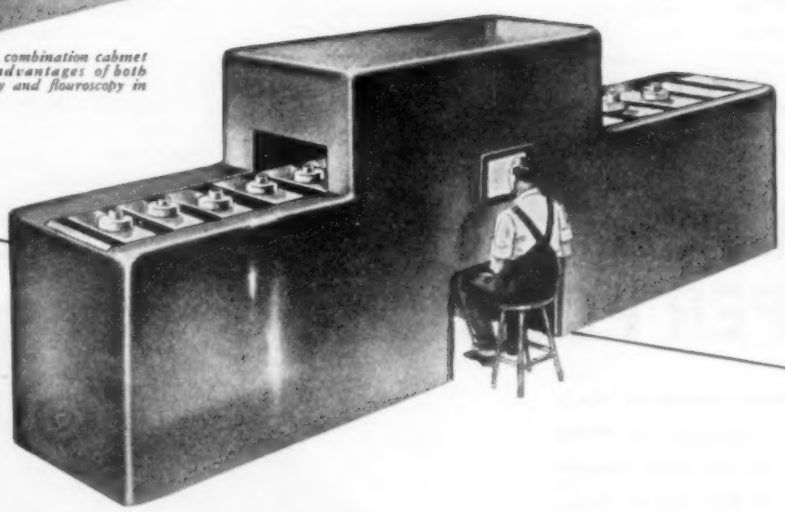
KELEKET *radiographic cabinet used for inspecting critical airplane parts.*





KELEKET's *mobile inspection cabinet operates fluoroscopically or radiographically.*

KELFKET *combination cabinet provides advantages of both radiography and flouroscopy in one unit.*



KELEKET's *conveyor belt fluoroscopic cabinet for high-speed, continuous inspection, may also be used radiographically.*

There is no question about X-ray's performance in industry today—nor the job it can do on the product you make.

Castings? Welds? Complete assemblies? Only X-ray inspection can detect every defect speedily, inexpensively, non-destructively, and before costly machining operations are performed. Marvel of industrial efficiency, no modern plant will do without it.

KELEKET—the quality name in X-ray—knows industrial inspection through and through. KELEKET knows above all that X-ray equipment must fit your plant. That's why KELEKET incorporates X-ray into cabinets—fluoroscopic, radiographic, or a combination of both—if that's what your production set-up requires. That's why KELEKET cabinets are stationary or mobile—or even conveyor units that become an integral part of a moving assembly line.

Hundreds of KELEKET installations in plants all over the country are improving products, cutting costs, and preventing failures in use. Tell us your problem, show us your plant, and we'll demonstrate how X-ray can serve you best.

KELEKET representatives are located in 64 cities in the U. S. and Canada—consult the one nearest you or write direct to Covington for complete information.

KELLEY-KOETT X-RAY MFG. COMPANY

0000 WEST FOURTH ST., COVINGTON, KY.

PIONEER CREATORS OF QUALITY X-RAY EQUIPMENT SINCE 1900

with a permanent record of such procedure. All design plates are clearly marked with the fundamental welding symbols of the AMERICAN WELDING SOCIETY and welding symbols are illustrated and described fully on a separate page in front of the book.

A cross reference "Short Cut to Design Ideas" index saves a great deal of time as it indicates the numbers of various design plates, that involve certain specific details such as bases, bosses, columns, frames, gussets, lugs, stiffeners, etc., that are common in many welding applications.

POSTWAR RESISTANCE WELDING PROCESSES

Maximum Efficiency Is Possible When Metal Products Are Designed for Welding

A recent statement by Floyd E. Taylor, President of the Resistance Welder Manufacturers' Association, contains timely advice for manufacturers now thinking in terms of improvements and economies for their postwar products.

"As the tremendous advances in resistance welding techniques on all types of metal ware equipment maufacture begin to be known, makers of a wide variety of products from instruments to heavy machinery are naturally beginning to figure where and how welding may be applied to their problems," states Mr. Taylor. "Actually, there are few types of metal products indeed wherein resistance welding processes will not play increasingly important roles. When the full story of war developments can be told, even men who thought they knew 'all about welding' are going to be amazed.

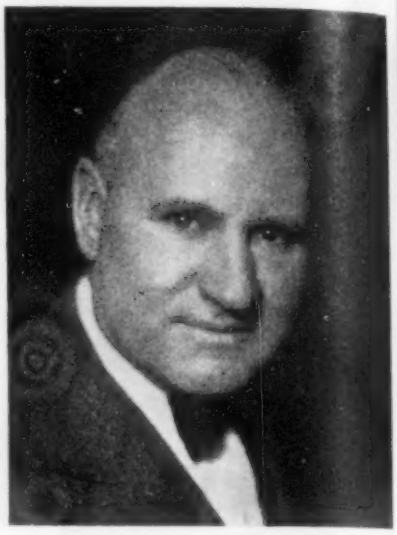
"The big point to remember, however, is the fact that resistance welding is not something to be thought of at the last minute, just as products are about ready to be put into production. Actually, resistance welding scores its biggest economies and manufacturing improvements when the product itself is designed for welding. Welding can, of course, be adapted to many present designs successfully—and often has been. On the other hand, design engineers who think in terms of resistance welding while designing their products may be pleasantly surprised at the far greater degree of efficiency that may be achieved."

Among the types of products cited by Mr. Taylor wherein resistance welding processes are progressing rapidly are: radios and other electrical appliances; such small items as optical frames; watches; vacuum tubes; alloyed wire fabricators; electrical devices of all types; jewelry; toys; novelties; cutlery; tools; hardware; as well as larger products such as truck axles; refrigerators; washing machines; and many others in addition to the more conventional applications with which most people are already familiar.

Requests for information on resistance welding problems or equipment will be handled promptly through the Resistance Welder Manufacturers' Association, 505 Arch St., Philadelphia 6, Pa.

JEFFRIES A BATTELLE DIRECTOR

Dr. Zay Jeffries, noted scientist and a pioneer in tungsten metallurgy and in the development of high-strength aluminum alloys, has been elected to the board of trustees of Battelle Institute, industrial research organization in Columbus, Ohio, it was recently announced.



Dr. Jeffries is technical director of the Lamp Department of General Electric Co., Cleveland, Ohio; chairman, Carboloy Company, Inc.; and vice-chairman of the War Metallurgy Committee of the National Academy of Sciences and National Research Council.

WELDED CONSTRUCTION IN MODERN MACHINE TOOL DESIGN Calls For PROPER POSITIONING

Manufacturers of modern machine tools are effecting substantial savings in time and money by positioning machine bases and other weldments with Ransome Positioning Equipment.

The downhand welding position for all weldments, provided by this equipment, assures superior weldments in less time, using a heavier rod and reducing rod waste.

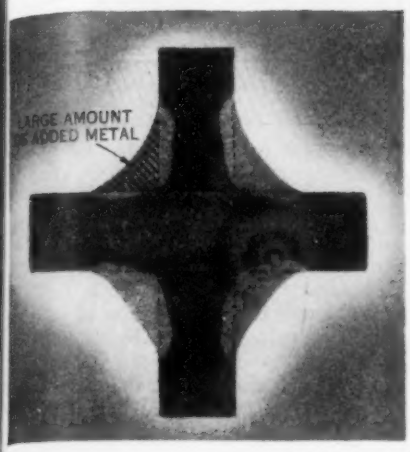
Economy and quality in manufacturing is necessarily part of your post-war plans. Investigate this modern production method. We will be glad to provide the proper equipment for your particular job.

WRITE FOR DETAILS—OUTLINE YOUR SPECIFIC PROBLEM

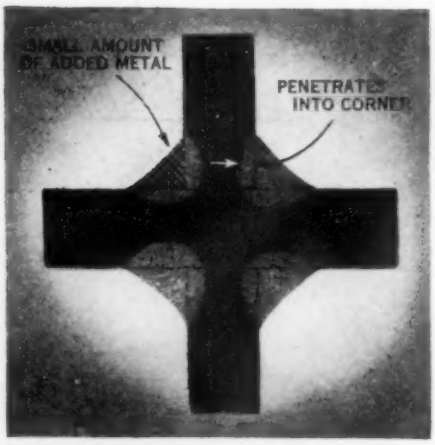
INDUSTRIAL DIVISION Ransome MACHINERY COMPANY
DUNELLEN, NEW JERSEY
SUBSIDIARY OF WORTHINGTON PUMP AND MACHINERY CORPORATION

"A War Measure of First-Class Magnitude"...he says

CONVENTIONAL WELDING

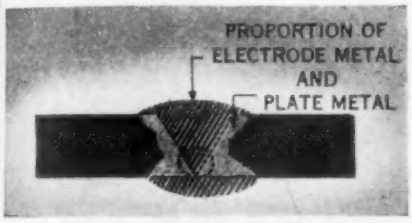


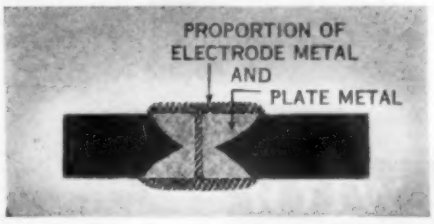
"FLEET-WELDING"



TYPICAL FILLET WELDS

STRENGTH:	Stronger than plate	STRENGTH:	Stronger than plate
SPEED:	5" per min.	SPEED:	12" per min.
COST:	100%	COST:	42%





TYPICAL BUTT WELDS

STRENGTH:	Stronger than plate	STRENGTH:	Stronger than plate
SPEED:	2" per min.	SPEED:	9" per min.
COST:	100%	COST:	25%

LOOK, MAHATMA: While you pondered on the magnitude of political measures for winning, Lincoln Engineers were enthusiastically working out a very practical measure that is away out in front in magnitude:

"FLEET-WELDING"

A First-Class Production Measure ... of First-Class Magnitude

This new, revolutionary technique using "ARC-FORCE" to speed the welding of all types of joints in plate, shapes and sheet is bringing back reports of 25% to 75% faster welding . . . also savings in electrode material and power. Cases also are reported where back-chipping and plate beveling are eliminated.

The savings shown at left are typical of this new technique developed by Lincoln engineers.

A Lincoln engineer is available nearby to help you apply "Fleet-Welding" Technique. Write for Bulletin No. 440 which gives complete explanation of the simple technique and the welding procedures.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

America's greatest natural **recourse**

ARC WELDING

PERFECT ALIGNMENT IN WELDED TUBE JOINT

The Meredith Welding Co., Los Angeles, Calif., are called upon by the various aircraft companies on the Pacific Coast for many intricate welded assemblies and welded joints.

Russell Meredith designed this joint for welding where perfect alignment had to be maintained in the welding of thick-walled tubing. This tubing part was to be machined inside and out both before and after welding. The male seat of the joint is removed in the final machining operation.

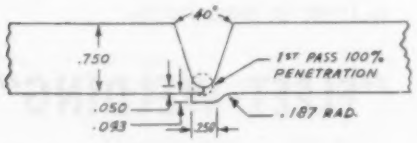


Fig. 1

In Fig. 1 the preparation of the joint is shown in the form of a male and a female seat, the male seat acting as a backing-up plate on inside wall of the tubing, allowing 100% weld penetration without leaving icicles on inside of tube. Fig. 2 is the wall of tube jointed and ready for welding. Figure 3 is an enlarged photograph of a longitudinal cut of the tube through the welded joint; note complete penetration.

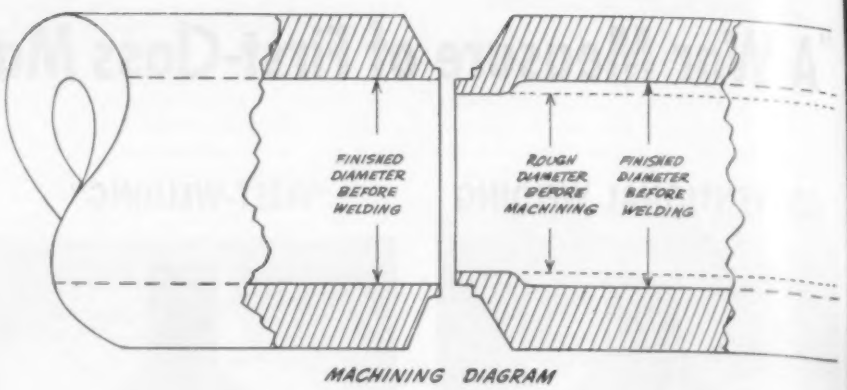


Fig. 2

Mr. Meredith emphasizes that many parts heretofore thought impossible to join together by welding can be welded without distorting if the joint is properly prepared.

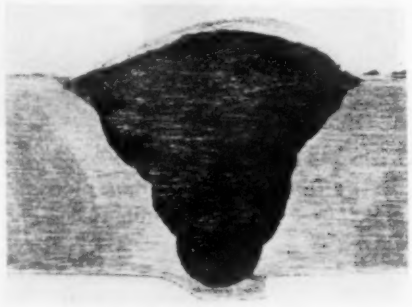


Fig. 3

This article was the winner of an award in Hobart Brothers Co. Arc Welding News Contest.

Drawings and photos, Courtesy Hobart Brothers Co., Troy, Ohio.

ARMY-NAVY "E" AWARD

The Studebaker Corporation is honored to announce that the Army-Navy "E" Award for Excellence in War Production was presented to the men and women of its Automotive Division on Tuesday, May 23, 1944.

GAIN 4 WAYS WITH PROTECT-O-METAL SPATTER-PROOFING COMPOUND

PROTECT-O-METAL pays a fourfold profit:

1. **Cuts after-welding clean-up time 90% because spatter will not adhere.**
2. **Makes welding easier and faster because PROTECT-O-METAL stabilizes arc and helps fusion.**
3. **Makes neater, stronger weld.**
4. **A gallon goes farther because it makes two or more gallons when thinned with water.**

PROTECT-O-METAL contains no volatile or inflammable ingredients to produce fumes and odors. Reduces spatter and porosity by minimizing gas formation. Inhibits rust. Prevents annealing scale. Provides better bond for paint or lacquer. Try it and see. Sample gallon $3.00 f.o.b. nearest shipping point. Satisfaction or no pay.

G. W. SMITH & SONS
110 S. SPERLING AVE.
DAYTON 3, OHIO

Time Counts—
Gas cut and Weld with
Shawinigan Carbide

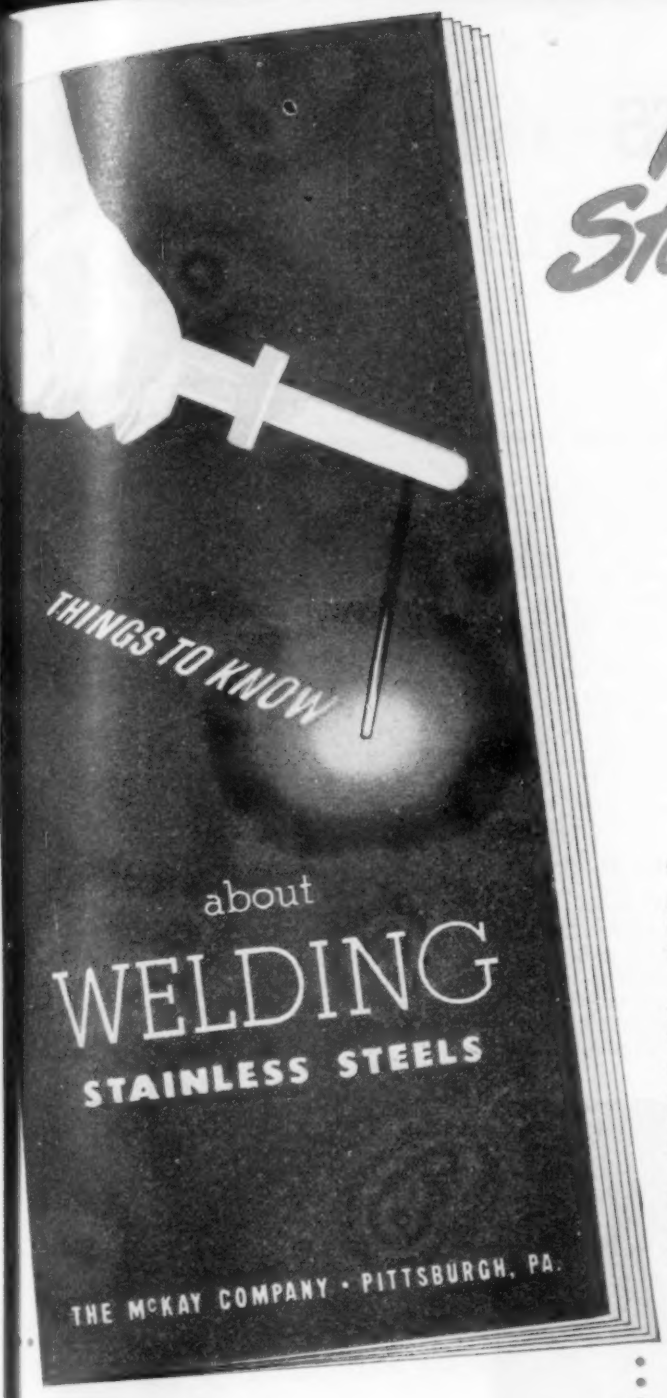
SHAWINIGAN
FOR VICTORY BUY UNITED STATES WAR SAVINGS BONDS AND STAMPS
SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

NET MONTHLY ADVERTISING RATES

Black and White — *Effective April 1943*

Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$120	$105	$95	$85
Half Page	70	60	55	50
Quarter Page	42	38	35	30
Eighth Page	30	25	20	18
*Inside Preferred	135	120	110	100

*10% Extra for bleed full pages. Color $40 Extra per color added.



Interested in Stainless Welding?

this Free Book answers many questions about Welding Stainless Steels

The more you know about the characteristics and reactions of stainless steel, in its many analyses, the better able you will be to cope with the problems of welding it.

The McKAY line of Stainless Steel Welding Electrodes is as *complete* as it is *excellent.* You can utilize each grade of McKay Electrode most effectively . . . and avoid pitfalls before you meet them . . . by keeping abreast of stainless developments. Stainless Steel has been called the "metal of the future." Know-how, gained now, will pay big dividends later.

Write for the FREE booklet "Things to Know About Welding Stainless Steels." It fully explains the answers to the quiz questions below and includes, as well, other valuable welding information.

Can You Answer these Toughies? The Free Book Explains 'Em Send for it Today!

		True	False
4.	The ability of Stainless Steels to resist corrosion is proportional to the amount of chromium contained in the steel.	☐	☐
5.	Titanium Metal is an excellent carbide stabilizer but if placed in Electrode Coatings or Core Rods it will not prevent Carbide precipitations in the weld metal.	☐	☐
6.	Grain growth in straight chrome steels is caused by carbide precipitation.	☐	☐

Answers: (4) True (5) True (6) False

Questions 1, 2, 3 appeared in last month's ad. Other questions will appear next month. Watch for them!

General Sales Office: York, Pa.

THE McKAY COMPANY PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

NEW PORTABLE TENSILE AND GUIDED BEND WELD TESTING MACHINE

A new and improved portable weld testing machine has just been introduced by the Air Reduction Sales Co., manufacturers of gas- and arc-welding equipment and supplies. Moderately priced, this machine is the only available portable-type unit that performs all these three weld tests: (1) reduced section transverse tension test; (2) guided bend test (a complete 180° face or root bend); (3) longitudinal all-weld-metal tension test (0.505 in.).

Two outstanding advantages of this machine are stressed by the manufacturer: first, its ability to provide accurate data on tensile strength and ductility of weld specimens, as determined by the three tests; and second, its relatively light weight which enables users to perform weld tests right on the job. This latter feature makes the machine particularly useful for firms doing extensive field work such as pipe-line installations, construction and similar jobs performed in remote locations.

The machine operates on the principle of the hydraulic jack. A hand-operated pump transmits pressure through a hose to the plunger. While the maximum direct load is 40,000 lb., the use of reduced section specimens permits tests on metals of 150,000 psi. or higher tensile strength.

Jaws for making the transverse tension test, and plunger and die for the guided bend test are supplied with the machine. Jaws for the longitudinal all-weld-metal tension (0.505 in.) test are furnished on special order. All standard equipment is installed in an oak cabinet which serves as a practical container for storage and shipment. The cabinet has handles at either end to facilitate carrying.

An illustrated booklet (ADI-88) describing construction and operation of this new Airco machine may be obtained upon request. Inquiries should be directed to the main office of Air Reduction Sales Co., 60 East 42nd St., New York 17, N. Y., or to any local Airco office.

A.-C. ELECTRODE

A new general-purpose electrode for mild steel, designated as "Fleetweld 35," and made specifically for operation on a. c., has just been announced by the Lincoln Electric Co., Cleveland, Ohio.

This new shielded arc electrode, which will also operate on d. c. with either polarity, depending upon the type of work being done, has all the desirable characteristics of the popular Lincoln "Fleetweld" electrodes for high-speed welding of single or multiple passes for work in flat, vertical or overhead positions.

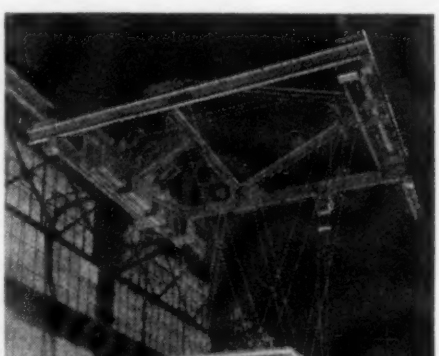
Available in $^1/_8$-in., $^5/_{32}$-in. and $^3/_{16}$-in. sizes, "Fleetweld 35" has exceptionally high physical properties, the as-welded weld metal specimens testing as follows:

Tensile strength...62,000–70,000 psi.
Yield strength.....52,000–57,000 psi.
Ductility (elongation in 2 in.)
....23–30%

"Fleetweld 35" conforms to AMERICAN WELDING SOCIETY specifications for arc-welding electrodes classes E-6010 and E-6011, is made in the standard 14-in. lengths and is packed in 50-lb. containers.

STABILIZED TRAVELING PLATFORM

The Cleveland Tramrail Division of The Cleveland Crane & Engineering Co., Wickliffe, Ohio, have developed a new Stabilized Traveling Platform that can be raised or lowered without swing as firmly as though held by vertical guides. It can be traveled to any point longitudinally or laterally in an area covered by the crane on which it is operated.



The Cleveland Tramrail Stabilized Platform was designed for spray painting large air cargo ships and to aid with some of the assembly operations. The floor area of the platform is divided into two sections: approximately one-third at the rear is for drums of paint and other equipment carried; the large space in front is for the painter's use.

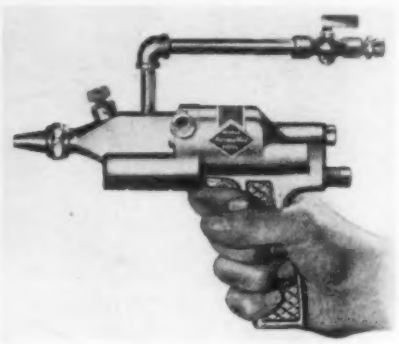
The unit illustrated herewith is of the all-welded steel construction. It will carry a load of 5 tons and has a hoisting speed of 18 f.p.m. This type of stabilized platform is suitable for operation through a vertical height up to 30 ft. and may be furnished for operation at any hoisting speed from creeping to 50 f.p.m., or more.

Applications where this can be used advantageously have been suggested for the steel, paper, textile and food industries.

RECLAIMING CASTINGS

The Mogul Nervous Weld Process is a new development of the Metallizing Co. of America, 1330 W. Congress St., Chicago, pioneer manufacturer of metallizing guns and equipment. This remarkable new process was developed primarily to solve the problem of reclaiming defective aluminum castings and can be used with equal success in salvaging bronze, grey iron, malleable and steel castings. Other important uses are the building up of surfaces for press fits, the repair of cracked housings, motor blocks, pump housings, as well as the preparation of surfaces for metallizing.

A complete installation to do this type of repair includes a Mogul Nervous Weld Pistol which requires approximately 60 lb. air pressure at 4 to 5 cu. ft. per minute and a Mogul Nervous Weld Machine, 110, 220, 440 volts, 60 cycle or 25 cycle, single phase. The latter unit is completely equipped with two 10-ft. lengths of cable, male and female receptacle, pair of goggles, heavy-duty ground clamp, 20-ft. length air hose complete with fittings, wall receptacle and complete instructions.

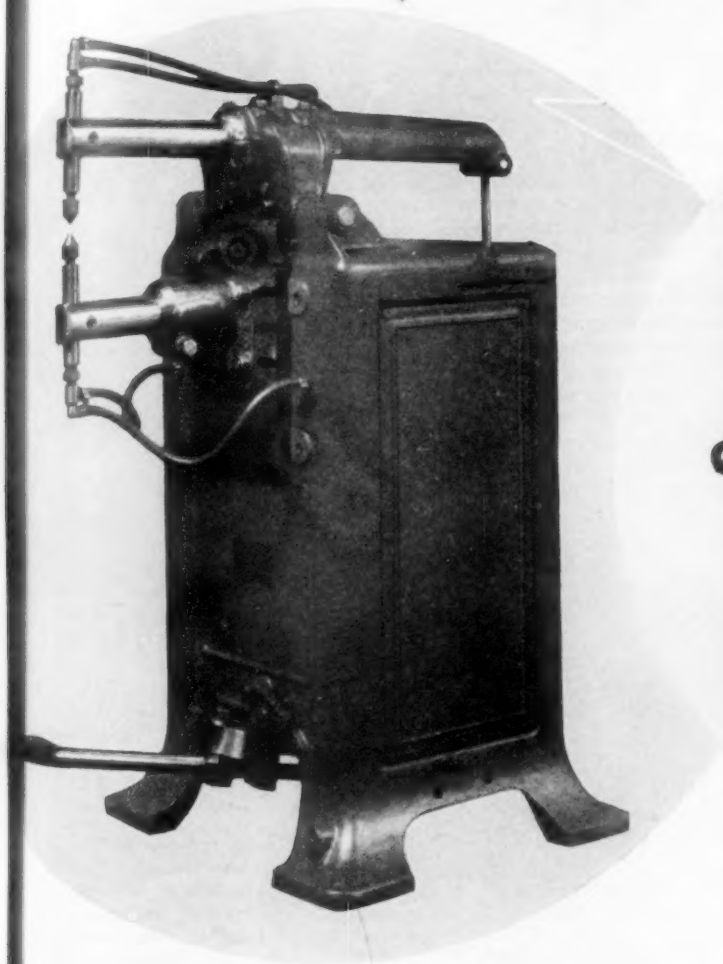


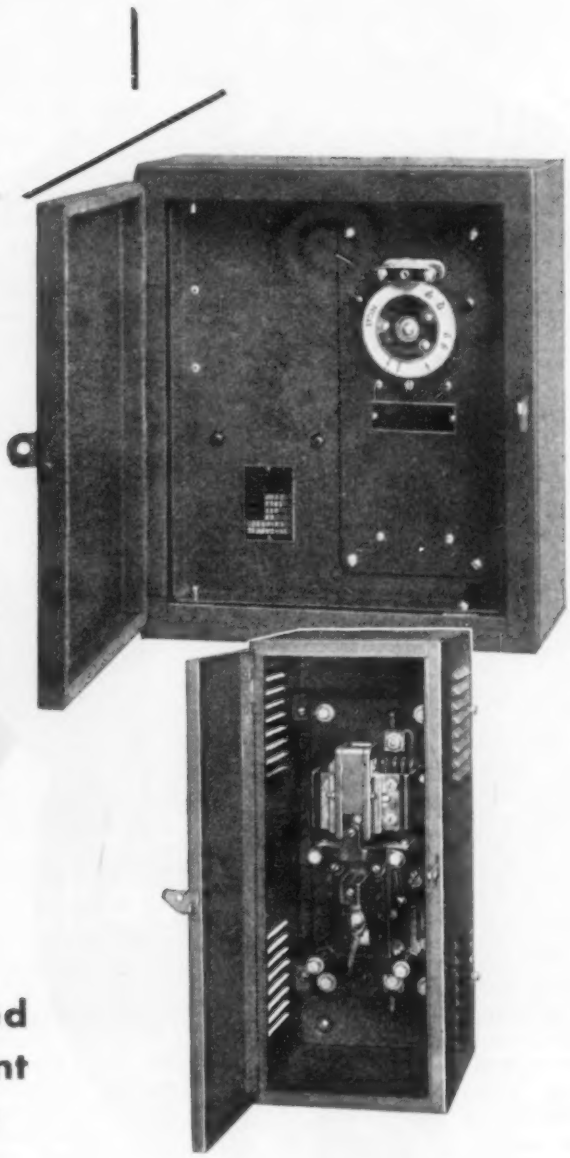
The Mogul Nervous Weld Pistol deposits atomized particles of metal which are welded to the surface and pressed, leaving a metal which is welded and forged.

Designed for manual operation, the rod (aluminum, bronze or nickel) is fed through the pistol by a trigger control and it is possible to feed $^1/_8$ to $^3/_8$ in. with one stroke of the finger-grip trigger.

One of the advantages of the Mogul Nervous Weld Pistol is that it eliminates stresses and distortion in the repair of defective aluminum castings. The temperature never rises above 125° and yet provides a deposit so dense at the point of fusion that there is no apparent line of demarcation. Even photomicrographs fail to show the line of demarcation. Aluminum castings, repaired with this unit, machine perfectly and withstand sodium hydroxide solutions used to prepare castings for alumilite plating.

How to modernize Spot Welders for as little as $105.00!





Safront Timer and High-Speed Contactor eliminate human element and assure *uniform* weld quality

Spoilage goes down and production goes up when welding power is controlled *automatically*. And it's a simple matter to equip machines, now in service, with modern timers and contactors for that purpose.

Your nearest Square D Field Engineer will be glad to check up on your present welding equipment. Quite often, such check-ups lead to substantial improvement in quality and output—at very little cost.

Top—**TYPE TBS-1 SAFRONT TIMER** automatically controls duration of welding current. All "live" parts are behind a protective panel. Timer adjustments can be made simply by turning the small knurled wheel on the panel front. Timer dial is calibrated 3 to 100 cycles.

Bottom—**HIGH-SPEED CONTACTOR** closes and opens the circuit to the primary of the resistance welding transformer. It is designed specifically for fast operation and heavy loads. Notice ample ventilation and generous wiring space. Knockouts for conduit entrance are provided in both top and bottom.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

electronic Weltronic bulletins

FULL-ELECTRONIC SEAM WELDER CONTROLS

A new degree of flexibility of timing adjustment combined with the ultimate precision of full-electronic control of every phase of seam-weld timing, is provided in two Weltronic cabinet model interchangeable panel type timers. Compact, easy to install and service, the controls are adaptable to old as well as new machines.

Both the Model #40 and #41 have independent adjustments for heat and cool time in 1 to 30 cycle steps. In addition, the model 40 can also be used for pulsation or spot welding at the flick of a switch.

Timing is synchronous, phase shift heat control is provided, contactors are Ignitron type. Eliminates linesurges, double-firing and mis-firing.

Ask for Bulletin WT-40-41

Weltronic COMPANY

DETROIT 19, MICH.

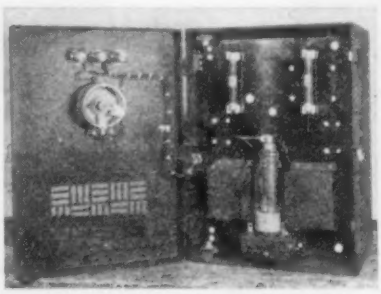
Operating features of this new unit include power chamber and peening motor, air-cooled nozzle, which keeps electrode as well as the work cooled, finger trigger which permits manual wire feed, needle valve to regulate air supply and electrode lug-connector.

For further information write direct to Metallizing Co. of America, 1330 West Congress St., Chicago 7, Ill.

NEW SPOT WELDING TIMER AND HEAT CONTROL

Suitable for welding small objects of high conductivity such as aluminum or copper, a new precise welding timer with heat control for timing intervals of one-half cycle or less is announced by Westinghouse Electric and Manufacturing Co.

Precise, because the welding current is made to start at the same point on the voltage wave for every operation, the new SP-18, 1/2-cycle timer is designed for welding of such items as radio tube parts and sockets, pig-tail resistors to terminal lugs, watch and instrument parts, contact tips on electrical relays and other small parts.



Type SP-18 Spot Timer, Showing Accessible Swing-Out Panel

The timer is furnished as a separate control for use with existing small bench welders and also in combination with a small welding transformer. Only one control tube is used, this thyratron serving the dual purpose of rectifying alternating current to charge a firing capacitor and also firing the small ignitron power tube. Heat control is accomplished by a phase shift method, the adjustment dial for which is mounted on the cabinet door.

Further information on this timer, rated at 230/460 volts, 50/60 cycles, may be secured from Department 7-N-20, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

NEW METALLIZING GUN SPRAYS ZINC, TIN, LEAD, COPPER

Metallizing Engineering Co., Inc., announces the introduction of the METCO Type 3E metallizing gun—specially engineered for the high-speed production spraying of low melting point metals. Using 1/8-in. zinc, tin, lead, solder, babbitt, cadmium, or fine gage copper and copper alloys, this new gun exhibits spraying speeds which exceed by far any yet attained with these metals. Rates of deposition, in pounds per hour, include zinc, 40; tin, 70; lead, 110; solder, 90; babbit, 75.

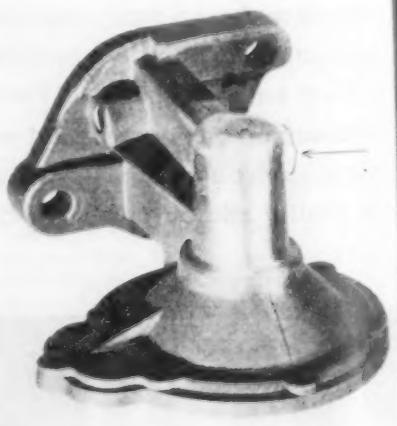
Regardless of the type of wire employed, no gear changes whatsoever are necessary to achieve these extraordinary high speeds. *Any* spraying speed within the prescribed ranges is automatically obtained, and maintained hour after hour, by the patented Controlled Power Unit—an integral part of the gun. Air-pressure fluctuations do not affect its operating efficiency.

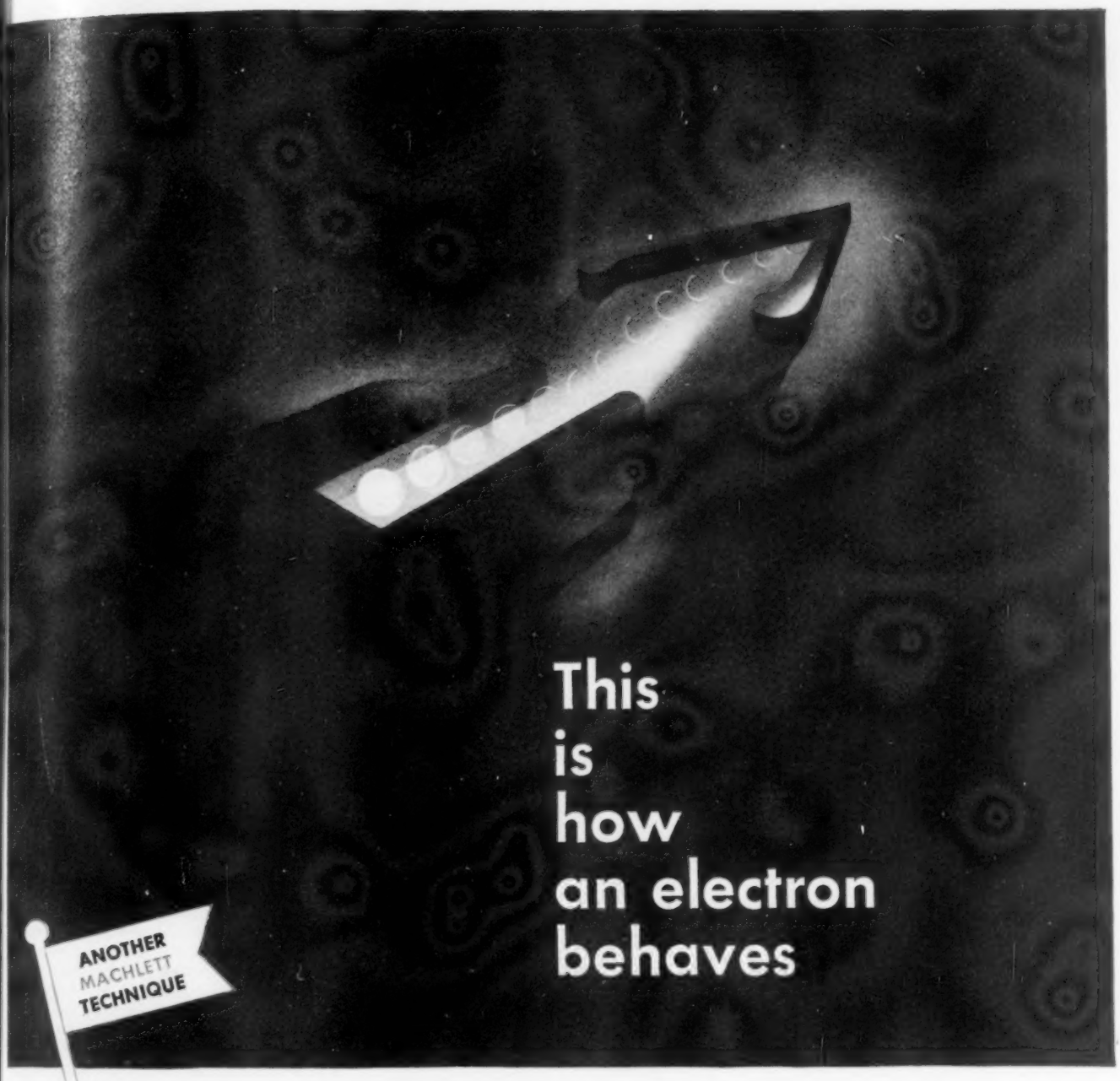
Full particulars are obtainable from the manufacturer—Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City 1, N. Y.—by writing for Bulletin 46.

SALVAGING ZINC DIE CASTINGS

Zinc base die castings, which are normally difficult to repair, can now be easily and effectively reclaimed with the improved gas welding rod 195 that is now being marketed by the Eutectic Welding Alloys Co., 40 Worth St., New York 13, N. Y.

The new rod 195 has a lower melting point and a still lower bonding temperature than the original alloy, which make it easier to apply without danger of damaging the parent metal. The improved rod is also easier to build up with, has greater tensile strength, and matches the hardness of the die castings.

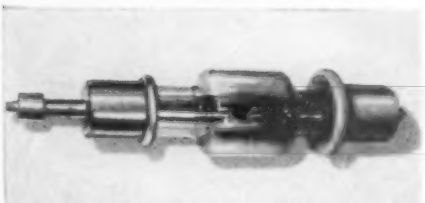




In designing a new electronic tube, mathematical calculations are invaluable, but as every designer knows, they are but preliminaries. After them, there usually come many tests of various experimental tubes. Machlett thought the cut-and-try method not only wasteful, but not productive of the best results. So we shortened and simplified the procedure by what our laboratory people call the "rubber model."

Here is a stretched rubber sheet. At the high end is a model of the cathode (electron emitter) of a proposed tube, and at the other end the anode, or target of an X-ray tube, plate of an oscillator or rectifier. The slope between the two is proportional to the desired potential difference. By means of an electro-magnet, a steel ball can be held in any position along the cathode, then released to roll under gravity to the anode, where the point it strikes can be observed and measured. *This is an electro-mechanical analogy.*

By means of this rubber model technique, months have been shortened into days, weeks into hours. More than that, new and higher performance has been achieved in the final product, so that when you buy a Machlett tube, you are assured of precise results, longer life, greater economy . . . Machlett Laboratories, Inc., Springdale, Connecticut.



The Machlett IR-250 is employed in industrial radiography and is an outstanding example of the X-ray tube art. Maximum capacity, 250 KV.

MACHLETT

X RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

An excellent example of what can be accomplished with EutecRod 195 is shown in the accompanying picture of a zinc base fuel pump die casting which had the whole top section broken off. Previous attempts to build up the part with ordinary rods had been futile, for at the point at which the alloy had to be applied there was a hole approximately $^{3}/_{8}$ to $^{1}/_{2}$ in. in diameter. This hole had to be bridged without the help of a backup material inside the assembly.

The break was "V'd" out to about a 90° angle and the section to be welded was cleaned thoroughly. The entire casting was preheated with an acetylene excess flame to about 700° F., at which temperature EutecRod 195 bonds to zinc. Autochemic Eutector Flux 195 was sprinkled over the metal, and as soon as this melted the rod was placed in front of the torch.

The lug was built up to its normal height in less than five minutes, and only one inch of a $^{1}/_{4}$-in. thick rod was used. The manufacturer is now saving hundreds of these defective casting which had previously been discarded.

"C" CLAMP HOLDS DOUBLE ANGLE SHAPES

An improved toggle-action "C" clamp which securely holds a wide range of work has recently been developed by Detroit Stamping Co., 322 Midland Ave., Detroit 3, Mich.

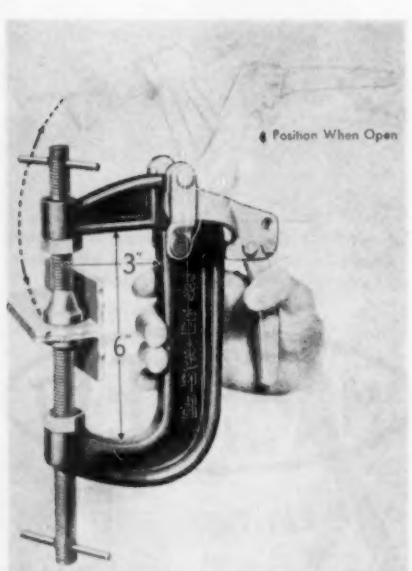
Two adjustable clamping spindles grip the work at any selected point, thus permitting clamping over double angles and other irregular shapes. The clamping gap is readily adjustable to any thickness within the clamp range. Each spindle is locked into its place and remains at that exact setting until manually readjusted.

Quick clamping and release are effected by rapid toggle action. Upon release the entire upper portion of clamp swings clear of the work, as indicated by the accompanying cut.

Other features of this improved clamp are these: body is a sturdy malleable iron casting. The threaded spindles are copper coated against welding spatter. Links and handle are plated against corrosion.

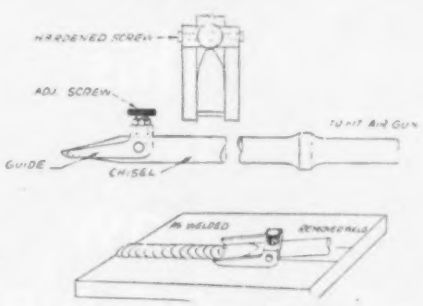
By changing location of retaining bolts the toggle handle may be adjusted to either straight out or downward position when clamp is locked.

This newly improved clamp is a 6-in. size, with extra deep 3-in. throat and is listed as De-Sta-Co Model No. 480. For further information write the manufacturer.



WELD-REMOVING CHISEL LOWERS COST AND FINISHING TIME*

This weld-removing chisel guide designed by Russell Meredith, Los Angeles, Calif., saves many hours of finishing time in an aircraft plant on the Pacific Coast. Its purpose is to remove the surface of the weld without injury to the parent metal. Attached to the end of an air gun, finishing of the weld is now being accomplished for 15¢ per foot, whereas by grinding, the cost had been 50¢ per foot.



Courtesy the Hobart Brothers Company.

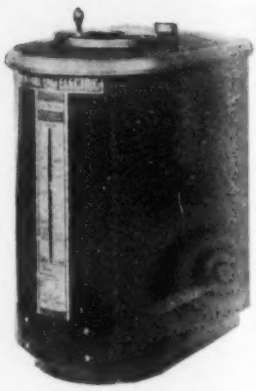
Originally designed for use on soft materials such as aluminum, bronze, Everdure, magnesium, etc., it may also be used on soft steel where flush, smooth finishes are required.

* This design was the winner of an award in the Hobart Brothers Co. Arc Welding News Contest of "Ideas for Victory."

OUTDOOR A.-C. WELDERS

Two new outdoor alternating-current welders, a 500-amp. type and a 300-amp. type, have been announced by the Electric Welding Division of the General Electric Co. The 500-amp. welder has a current range from 100 to 625 amp., while the range of the 300-amp. welder is from 60 to 375 amp. Both of the new welders are specifically designed for use in shipyards and similar outdoor locations where exposure to the weather is common.

These welders are equipped with an "idlematic" control which functions to reduce the output voltage automatically to less than 30 volts whenever the arc is not in operation, yet provides full power for welding directly the arc is struck. In addition, this control is provided with a switch, conveniently operated by a handle projecting through the top of the case, for shutting off the welder when not in use.



Protection against the entrance of rain, snow and sleet is provided by the drip-proof construction of all openings in the top of the sturdy enclosures of the welders, and by a sealed window over the current indicator. The ventilating openings serve both to shed water and to keep air velocity low. A special finish on all internal parts provides protection against corrosion from moist air.

These welders also incorporate all the desirable features of General Electric indoor a.-c. welders of this type, including built-in power-factor improvement, finger-tip adjustment, stepless current control and fan-forced ventilation.

EYECUP SAFETY GOGGLE

A new small-size eyecup safety goggle for women chippers is announced by American Optical Co., Southbridge, Mass. Designed for female workers whose eyes are exposed to the hazards of flying objects coming from any direction, the new goggle is fitted with clear, flat Super Armorplate lenses. Light in weight for comfort, the goggle is sturdily made for efficient protection and durability.

Several million women, the optical concern points out, are now working in factories, handling jobs formerly done by men. Many more women will undoubt-

7 REASONS WHY

Your best bet for AC Welding is a "Bumblebee"

with a *Stinger that Penetrates*

Every feature of design and construction, both inside and outside the sturdy case of the Wilson "Bumblebee", has been planned to give the utmost in efficient, dependable and economical service:

Precise, Stepless Adjustment of Welding Current to any value within NEMA range, provided by easy-turning crank.

Efficient Ventilation by motor-driven fan assures safe, dependable operation, even when welding with maximum current.

Reduced Power Factor Charges and relief for overloaded power lines is provided by built-in capacitors.

Coils Protected Against Fire and Vermin by mica and glass fabric insulation.

Interchangeable Primary Terminals permit easy, rapid change from low to high line voltage or vice versa.

Output or Secondary Terminals Readily Accessible by removing 4 screws which hold small insulating panel.

High Visibility of Current Indicator is assured by large, easily read calibrated scale located outside case.

These features are incorporated in every "Bumblebee" welder—either regular or all-weather model. "Bumblebee" welders are also performing a valuable service as a power source for automatic welding heads.

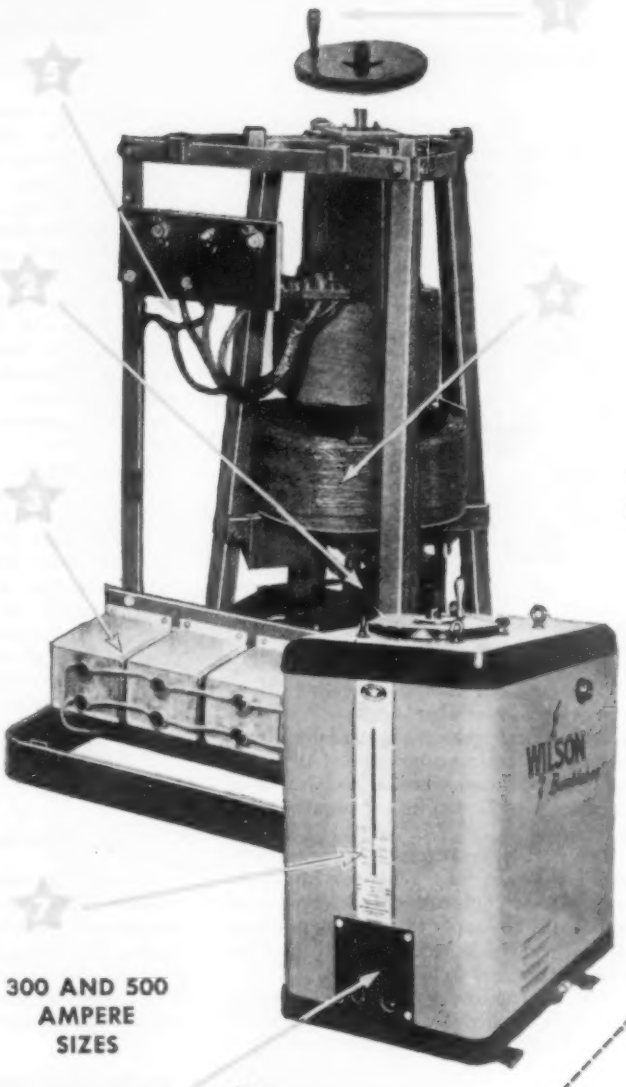
In addition, the "Bumblebee" offers all the advantages of AC welding:

- —Low Maintenance because of absence of moving parts
- —Low Power Costs because of high electrical efficiency
- —Faster Welding due to absence of arc blow and use of larger electrodes
- —Improved Quality of Welds

—at no greater first cost than other types of welding equipment.

Other AC welders in 100, 200, 750, 1000 ampere sizes.

Mail the coupon today for new catalog—or write to your nearest Airco office.



300 AND 500 AMPERE SIZES

BUY UNITED STATES WAR BONDS

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AIR REDUCTION

General Offices: 60 East 42nd Street, New York 17, N. Y.
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Gentlemen:

Please send to me by return mail a copy of the "Bumblebee" AC Machine Catalog (ADW-53).

Name.....

Company.....

Address.....

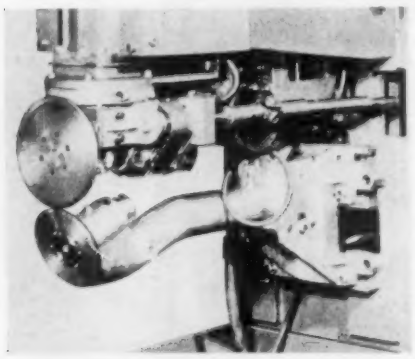
City..... State.....

edly enter industry before the war is won. This enormous influx of women has created an urgent demand for small-size cup type goggles for chipping operations, the reason behind the development of the new goggle with its 44.6-mm. eye size.

Each eyecup is designed individually to fit the orbit of the eye. There are broad bearing surfaces for comfort, and the goggle is low set for wide angle vision. It has an insulated ball-chain bridge which can be adjusted easily and quickly. The headband is likewise adjustable.

SEAM WELDER FOR WELDING CLOSE TO CORNERS

As the illustration shows, the lower welding wheel is in an angular position which permits seam welds close to corners of metal boxes, ducts, etc. An angular set may be given both the upper and lower welding wheels as conditions warrant.



The wheel drive shown in the Thomson Welder pictured is upper welding wheel gear driven, lower wheel idling. A variety of driving arrangements is available—gear or knurl drives may be applied to either the upper or lower wheel or to both welding wheels, as best suits the requirements of the work.

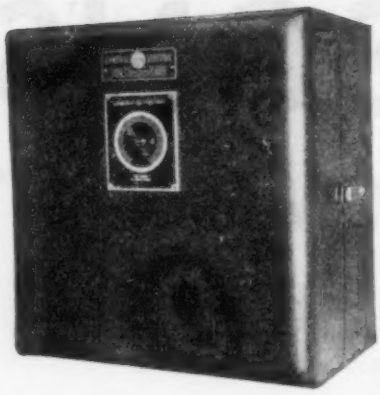
This angular arrangement of the welding wheels is shown on a Thomson Model 25 Seam Welder equipped with double-acting air cylinder to supply the welding pressure and with variable speed drive to provide an ample range of welding speeds.

Full information on this development may be obtained by writing Thomson-Gibb Electric Welding Co., Lynn, Mass.

ELECTRONIC CONTROL ELIMINATES EFFECT OF VOLTAGE VARIATIONS

A new voltage regulator for use with most G-E resistance-welding controls that include the phase-shift method of heat control, has been announced by the Industrial Control Division of the General Electric Co. The new regulator is designed to regulate the welding current automatically, so that it is held constant regardless of line-voltage variations of as much as plus 10 or minus 20%. Hence the quality of the weld is greatly improved and continuous readjustment of the heat setting is unnecessary.

Known as the CR7503-D157, the regulator consists of a resistor circuit connected to the power line which supplies



the welding machine, and an electronic circuit. When the regulator is in use, this electronic circuit functions not only to hold the average voltage of the resistor current constant, but also changes, electronically, the phase control voltages of the main welding control panel. Thus if the line voltage drops, which normally would cause the current through the welding transformer and the voltage of the resistor circuit to vary correspondingly, the regulator advances the phase control voltages, thereby automatically holding the welding current constant within close limits.

The regulator, which is housed in a sturdy, easily opened steel enclosure, can be used on welding circuits whose power factor is from 20 to 70%, and can be operated from 230/460/575 volts on a 50/60-cycle power supply. It operates whether or not the welding current is flowing. This feature enables it to compensate for a sudden voltage drop in less than three cycles, with approximately 75% of the compensation taking place during the first cycle.

WELDING FITTINGS

To meet requests for a book covering welding fitting dimensions specified in naval and maritime shipbuilding, Tube Turns, Louisville, Ky., announces its new maritime fittings catalog No. 112. Section 1 of this 48-page plastic-bound book contains dimensional data on seamless wrought steel and wrought iron fittings. Section 2 gives similar coverage to wrought carbon molybdenum alloy steel. Each section is fully indexed and is complete with cross-section illustrations of each fittings.

TWO MORE SOCIETIES TO MEET AT METAL CONGRESS

Two additional technical societies will participate in the forthcoming National Metal Congress and War Conference Displays, to be held in Cleveland's Public Hall the week of October 16th. They are the Society for Experimental Stress Analysis and the American Industrial Radium and X-Ray Society. Other cooperating societies in the Congress are the American Society for Metals, sponsor of the event, the Iron and Steel and Institute of Metals divisions of the American Institute of Mining and Metallurgical Engineers, and the AMERICAN WELDING SOCIETY.

"With these five national societies planning some 150 research papers for presentation at the Congress, the most interesting program in the 26-year history of the event is guaranteed," said W. H. Eisenman, national secretary of the American Society for Metals and managing director of the Congress and Displays.

Nearly a thousand men are collaborating in the preparation of this year's program which will begin on Monday, October 16th, and run through Friday, October 20th, Eisenman continued, pointing out that "all branches of the metal industry are represented in these five societies."

The Society for Experimental Stress Analysis has national headquarters at the Massachusetts Institute of Technology, with Prof. W. M. Murray of M.I.T. as president.

During the Metal Congress the S.E.S.A. will have headquarters at the Carter Hotel, Cleveland. Technical sessions will be held both morning and afternoon on Tuesday, Wednesday, Thursday and Friday, October 17th through 20th, with the annual dinner meeting on Thursday evening.

The American Industrial Radium and X-Ray Society will have technical sessions for mornings and afternoons on Thursday and Friday, October 19th and 20th, with a special meeting of the Cleveland Section on Monday, October 16th, and the annual meeting of the Society on Thursday afternoon. Convention headquarters will be at Hotel Hollenden.

The American Society for Metals will have headquarters during the Metal Congress at the Statler and the Hollenden hotels; the A.I.M.E. will be at the Statler, and the AMERICAN WELDING SOCIETY at Hotel Cleveland.

The Annual Meeting Program of the American Welding Society is published on pages 768, 770, and 772 of this issue.

G-R

MODEL 49...

for A. C. Welding at its Best

YOU'LL GET the fullest advantage of a. c.'s greater economy and higher welding speed, *plus* unsurpassed welding characteristics, with the G-R on your job. This husky production unit literally "has everything" for better welding at lower cost: built-in power factor correction, G-R VOLT-O-MATIC control, and an output range (25 to 625 amperes) that makes the G-R 49 ideal for every job, large or small.

Design Features

1. Built-in VOLT-O-MATIC control reduces open circuit voltage to less than 10 volts...absolute safety for operators . . . no "sting" when changing electrodes in wet weather.
2. Reliable built-in G-R power factor correctors reduce the current load on power supply lines.
3. Famous G-R "stepless" output control (pre-set indicator shown) gives you *exactly* the current you want, from 22 to 625 amperes!

FOR COMPLETE SPECIFICATIONS AND PRICES, SEE YOUR G-R DISTRIBUTOR OR WRITE DIRECTLY TO:

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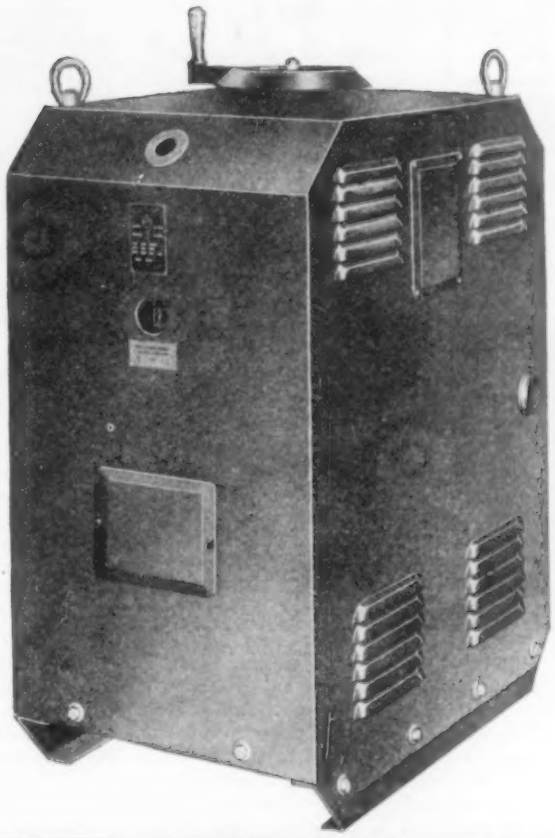


CONDENSED SPECIFICATIONS

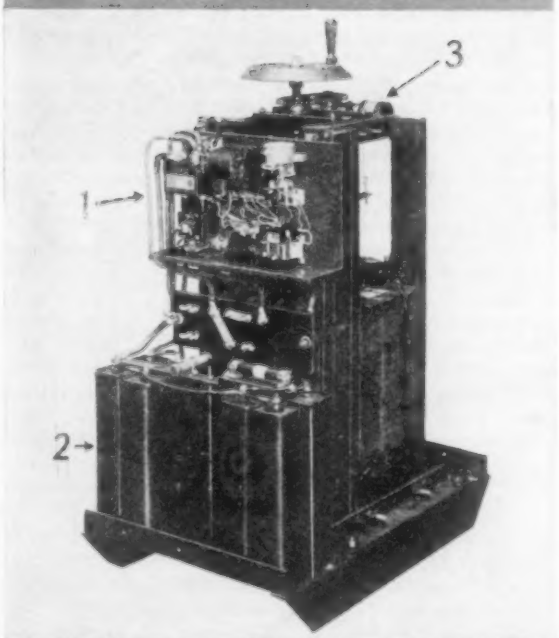
POWER SUPPLY: 220 or 440-volt, single phase, 50-60 cycle a. c.

OUTPUT (amperes) Minimum 25
Rated (NEMA) 500
Maximum 625

OVERALL DIMENSIONS: 22" wide, 46" high, 33" deep

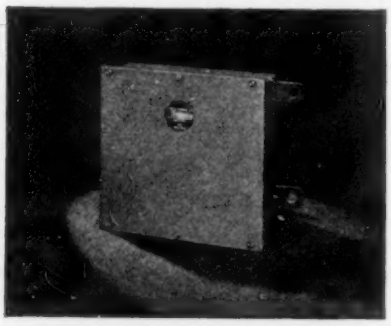
NET WEIGHT: 1,100 lbs. (stationary mounting)

MODEL 49...CASE REMOVED



ARC TIME RECORDER

The Arc Time Recorder has been developed to meet the urgent demand of the welding industry for a compact, reliable and inexpensive device which will supply the welding engineer with the most important single information of arc-welding operations, namely, *the actual arc time of each welding generator*. It consists essentially of a calibrated relay system which energizes a synchronous time re-



corder only when the arc is on. No time will be recorded when the arc is off or when the electrode is grounded to the work. The recorder totalizes arc time up to 99,999 min. on a cyclometer type dial which is read at the end of a specific welding operation or work shift in much the same way as an electric meter. Baier & Ackerman, Inc., 18 East 41st Street, New York 17, N. Y.

ANNUAL MEETING OF A.S.T.M.

With a record-breaking registration of members and visitors, totaling 2063, 16 formal technical sessions with several informal round tables, more than 250 meetings of the Society's technical committees, and a large number of actions on specifications and tests for materials, including over 50 new standards, the Forty-Seventh Meeting of the American Society for Testing Materials was a notable one. Held in New York over the five days, June 26 to 30, the meetings provided an opportunity for the country's leading materials technologists to convene and discuss important problems bearing on the country's industrial and war efforts.

Always a criterion of standardization work is the number of new tentative standards accepted for publication for the first time. There were over 55 of these. Another figure of concern is that of existing specifications which are proposed for adoption as formal A.S.T.M. standards—70 being so scheduled. Standards work was intensified because of the advancement by a full year of publication of the Society's Book of Standards, to come out late in 1944.

New Officers and Honorary Members

The following new officers of the Society were elected at the Annual Meeting: *President*, P. H. Bates, Chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D. C.; *Vice-President*, Arthur W. Carpenter, Manager, Testing Laboratories, The B. F. Goodrich Co., Akron, Ohio; *Members of the Executive Committee*, W. C. Hanna, Chief Chemist and Chemical Engineer, California Portland Cement Co., Colton, Calif.; L. B. Jones, Engineer of Tests, Test Department, The Pennsylvania Railroad Co., Altoona, Pa.; J. T. MacKenzie, Chief Metallurgist, American Cast Iron Pipe Co., Birmingham, Ala.; J. G. Morrow, Chief Metallurgist, The Steel Company of Canada, Ltd., Hamilton, Canada; Sam Tour, President, Sam Tour and Co., Inc., New York, N. Y.

Effect of Temperature on the Properties of Metals

Two interesting progress reports were included in the material presented to the Society by the joint A.S.T.M.-A.S.M.E. Research Committee on the Effect of Temperature on the Properties of Metals, the first covering the effects of variables on the creep resistance of steels, which is part of a long-time program. It covered particularly the effect of heat treatment on a silicon-killed and silicon-aluminum steel of the 1015 type. The other report included a correlation of short-time and long-time elevated temperature tests, which indicated among the conclusions that the best correlations were obtained from the following tests: sustained load tensile test; Hatfield time-yield test; DIN-DVN test.

ADMIRAL CARPENDER MAKES "E" PRESENTATION TO CHICAGO BRIDGE & IRON CO. PLANT

Rear Admiral S. Carpender, Commandant of the Ninth Naval District, made the formal presentation address in connection with the awarding of the Army-Navy "E" to the Chicago Plant of the Chicago Bridge & Iron Co. on July 11th.

The Chicago Bridge & Iron Co. was founded in 1889 and its first plant built on the site of the unit receiving the "E" Award on the 11th. In addition to operating this plant continuously for the past 55 years, other fabricating plants have been acquired at Greenville, Pa., in 1910, in Birmingham in 1930 and a Canadian organization, the Horton Steel Works, Limited, with a plant at Fort Erie, Ont., was established in 1914. Erection equipment warehouses are maintained at Hillside, N. J., Greenville, Pa., Chicago, Ill., Houston, Tex., and Torrance, Calif.

George T. Horton, President of the Company and son of the founder, accepted the award on behalf of the Company. This was his seventh acceptance and it gives the Company a batting average of 1000% in "E" pennants. Each of the Company's seven operating units—three plants, three dry-dock yards and a shipyard—has received the award.

The Chicago Bridge & Iron Co., as the name indicates, first dealt in the construction of iron and steel bridges. In the early 1890's the organization started building elevated water tanks and flat-bottom water storage tanks. This line of work supplemented bridge building almost entirely by 1912. During the last war, George T. Horton served as Vice-President and General Manager of the Submarine Boat Corp. and the Company's facilities were used to build sections for prefabricated cargo ships. After World War I the Company started building tanks and special steel plate construction for the oil industry. These include Hortonspheres, Hortonspheroids, Wiggins Roofs and refinery vessels. In other industries, Chicago Bridge has also built various types of steel plate work, such as steel pipe, radialcone tanks, waterspheres, wind tunnels, etc.

World War II activities include many installations of water tanks at training camps, steel pipe and toluene tanks at munitions plants and Hortonspheres at synthetic rubber, aviation gasoline and chemical plants. The larger portion of the Company's activities, however, are devoted to the construction of special work directly for the Navy, including several types of steel floating dry docks and a major schedule of LSTs. The Company's shipyard at Seneca, Ill., which is devoted to the construction of LSTs exclusively, is lead yard in the LST program. About one-half of the prefabricated hull sections of the LSTs built at Seneca are supplied by the Company's Chicago plant, the remainder coming from its plants at Greenville, Pa., and Birmingham.

LAYING OUT FOR BOILER MAKERS AND PLATE FABRICATORS

Now in its fifth edition, *Laying Out for Boiler Makers* for more than a third of a century has served as a guide for the solution of sheet metal and boiler plate layout problems. In this new edition some sheet metal problems have been left out to make space for heavier plate fabricating layouts. A chapter on the Scotch marine boiler was deleted to provide space for a long chapter on locomotive boiler construction and for a new one on Laying Out and Computing Boiler Patches. Another important new chapter is on Laying Out for Welded Construction.

Information is presented in shop language. Problems are worked out without recourse to higher mathematics. Layout problems by orthographic projection and triangulation are explained with the aid of more than 700 clear drawings, many of them new. All have been developed by experts and represent modern methods.

The material is arranged from simple to complex and the application of principles and methods is made clear by practical problems. The layout of boilers includes not only the materials but all calculations which must be made to determine the size of different parts. Detailed information on proper procedure from start to finish is given on a great variety of sheet metal and boiler plate layout work.

The beginner can use this book as a sound text for shop or home study. The journeyman will find in it hundreds of layout problems he is not familiar with. A complete cross-index makes it easy to quickly locate any problem or subject, so that it can be used as a handy reference. 522 pages. 8½ by 11 inches. Price $7.00. Simmons-Boardman Publishing Corporation, 30 Church Street, New York 7, N. Y.

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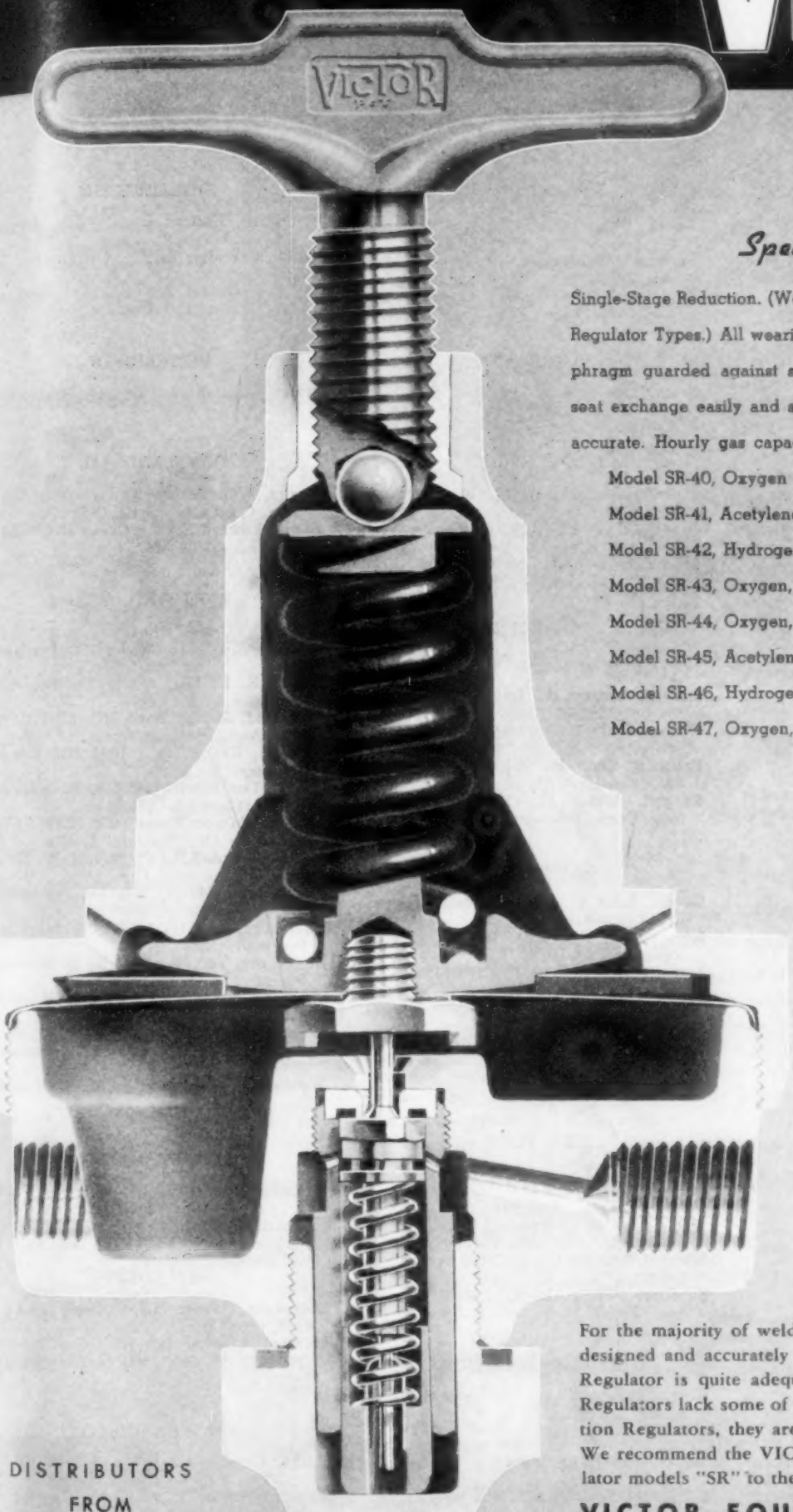

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Single-Stage Reduction. (We also produce Two-Stage Reduction Regulator Types.) All wearing parts adequately protected. Diaphragm guarded against shearing and buckling. Occasional seat exchange easily and swiftly accomplished. Very pressure accurate. Hourly gas capacity 1,840 cu. ft. p. hr. at 100 Psi.

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List of New Members

June 1 to June 30, 1944

BOSTON

Haberlin, William F. (B), 77 Robin St., Providence, R. I.
Paul, Walter (B), 19 Huse St., Lawrence, Mass.

CANADA

Patterson, John B. (C), 303 Ridout St., S., London, Ont., Canada.
Smith, George E. (B), 83 Broadview Ave., Moncton, N. B., Canada.

CANTON

Eichel, John A. (C), 1336 Arapahoe S. E., Massillon, Ohio.

CHICAGO

Bass, Wm. H. (B), 200 Ellsworth St., Gary, Ind.
Bauer, George C. (B), National Cylinder Gas Co., 4700 W. 19th St., Chicago, Ill.
Galbraith, Wilson I. (B), National Cylinder Gas Co., 4700 W. 19th St., Chicago, Ill.
McKibben, Richard P. (C), 7027 East End Ave., Chicago 49, Ill.
Pearson, Leonard (B), c/o Rockwell Engrg. Co., 10126 S. Western Ave., Chicago, Ill.
Witt, Albert F. (B), National Cylinder Gas Co., 4700 W. 19th St., Tech. Serv. Dept., Chicago, Ill.

CLEVELAND

Christie, Claude E. (B), 442 W. 8th St., Elyria, Ohio.
Stevens, Mike J. (C), Box 45, Marblehead, Ohio.

CONNECTICUT

Kemp, Arthur W. (A), Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.

DETROIT

Dodd, William (B), 22450 Pembroke Rd., Detroit, Mich.
Purcilly, Peter T. (B), Carrick Prods., 410 So. Main St., Clawson, Mich.

INDIANA

Neff, James R. (B), 2630 Ryan Dr., Indianapolis, Ind.

LEHIGH VALLEY

Fine, Kenneth F. (B), 809 N. Franklin St., Pottstown, Pa.

LOS ANGELES

Downey, F. G. (B), U. S. Naval Repair Base, Ind. Com. 5 I, San Diego, Calif.
Harkins, Frank G. (B), Solar Aircraft Co., San Diego 12, Calif.
Johnston, Robert L. (C), 1939 Pacific Coast Hwy., Lomita, Calif.
Keech, Charles W. (C), 12010 Wilmington Ave., Willowbrook, Calif.
Sageman, George N. (C), Box 906, Wilmington, Calif.
Showalter, John E. (B), Box 673, San Ysideo, Calif.

LOUISIANA

Bramblett, James E. (B), P. O. Box 1804, Baton Rouge 2, La.

LOUISVILLE

Johnson, Wm. M. (B), 541 Whitney Ave., Louisville 8, Ky.
Jones, Calvin E. (B), 1034 Queen Ave., Louisville 8, Ky.
Meredith, Robert Lee (C), 952 Weissinger-Gaulbert Apts., Louisville, Ky.

MOBILE

Duke, R. A. (B), 305 Third St., Chickasaw, Ala.
Dunlop, Andrew H., Jr. (B), 968 Arlington St., Mobile, Ala.
Norris, W. O. (B), 307½—7th St., Chickasaw, Ala.
Prentice, Cecil H. (B), 238-C Hasting St., Chickasaw, Ala.
Swigert, Arthur M. (B), Ingalls Shipbldg. Corp., Pascagoula, Miss.

NEW JERSEY

Green, John C. (C), 522 Adams Ave., Elizabeth, N. J.
Kisco, Edward F. (B), 1602 S. Clinton Ave., Trenton 10, N. J.
Lamoreaux, Frank (C), 209 Clifford St., Newark 5, N. J.
Marshall, John A. (C), 534 Prospect St., E. Orange, N. J.
Shancey, Edward A. (C), R. F. D. 2, Rahway, N. J.
Wright, B. W. (B), 183 Laurel Hill Rd., Mountain Lakes, N. J.

NEW YORK

Langhirt, G. F. (C), 124 Johnson Ave., Teaneck, N. J.
MacCorkindale, Douglas (C), Lloyds Register of Shipping, 17 Battery Place, Rm. 1012, New York, N. Y.
Mirabel, Charles C. (C), 2162 Stuart St., Brooklyn 29, N. Y.
Saponaro, Philip J. (C), 2416 Tiebout Ave., Bronx, N. Y.

NORTHERN NEW YORK

King, William T. (C), 25 Schuyler St., Albany 2, N. Y.

NORTHWEST

Benjamin, Paul (B), 1715 E. Hoyt Ave., St. Paul 6, Minn.

PHILADELPHIA

Campbell, Hallock C. (C), 518 Merwyn Rd., Narberth, Pa.
Grauert, Walter E. (C), 410 Ann St., W. Reading, Pa.
Ostrom, Gustaf A. (B), 510 Montana Ave., Aldan, Del. Co., Pa.

PITTSBURGH

Handy, Clifton H. (C), 310 Market St., Brownsville, Pa.

PORTLAND, ME.

Briggs, William (A), New England Shipbldg. Corp., So. Portland 7, Me.
Sonia, Edward E. (C), Ocean House Rd., Cape Elizabeth, Me.

PORTLAND, ORE.

Crumley, J. H. (B), Hesse Ersted Iron Wks., 816 S. E. Taylor St., Portland, Ore.
Davis, E. P. (B), Route 11, Box 803, Portland, Ore.
Desmond, Robert Boyd (B), 3721 N. E. 23rd Ave., Portland, Ore.
Haindel, Roy R. (C), 1655 No. Jessup, Portland, Ore.
Heath, Leo B. (B), 4021 S. E. Madison St., Portland 15, Ore.
Hemley, Myron Reese (C), 10263 S. W. Riverside Dr., Portland 1, Ore.
Huston, Randall R. (C), 2555 N. W. Thurman St., Portland, Ore.
Pusc, Walter M. (B), Route 4, Vancouver, Wash.
Saulsbury, J. L. (B), 10607 S. E. Stark St., Portland, Ore.
Suderburg, Ted (B), 3275 N. E. Holman, Portland 11, Ore.
Weitman, Eugene A. (C), 3155 N. Winchell St., Portland 3, Ore.
Wentworth, W. R. (B), Kaiser Co., Inc., Portland Yd., P. O. Box 4259, Portland 8, Ore.
Wohlwend, Lewis A. (B), 2517 N. Halleck St., Portland, Ore.

PUGET SOUND

Bairstow, Robert W. (C), American Chain & Cable Co., 2426—42nd North, Seattle 2, Wash.

ST. LOUIS

Derickson, Gayden (B), c/o Shell Oil Co., Inc., Wood River, Ill.
Hibbler, Charles L. (B), John Nooter Boiler Wks. Co., 1400 S. 2nd St., St. Louis 4, Mo.

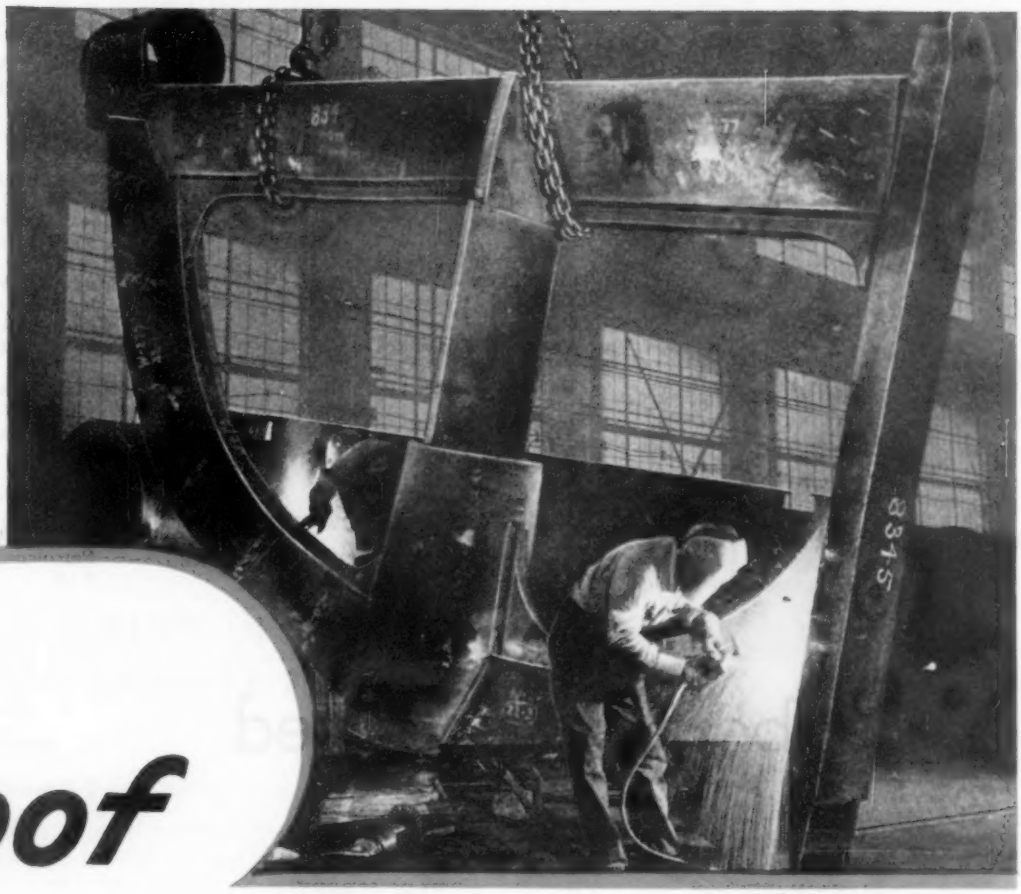
SAN FRANCISCO

Hartz, George A. (C), 217 Coral Rd., Apt. 473, Vallejo, Calif.
Heakin, Harold L. (B), 224 Townsend St., San Francisco, Calif.

SMITHway Electrodes in Action

This large, all-welded structure weighing 28,000 pounds is one of a number of stern frames for cargo ships being produced in the A. O. Smith plant for Walter Butler Ship Builders, Inc., at Duluth, Minnesota.

It is another example of the many applications of SMITHway welding technique that is speeding production in the war effort.



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YOU won't find welding electrodes *anywhere* that are put through the paces we give them in our own testing laboratories. That's because *thoroughness* is *fundamental* with us.

And that's fine as far as it goes. But our *real* test is our *shop* test—where over 320,000 electrodes a day go *into actual production* . . . into welded products we make right here in the A. O. Smith plant . . . into some of the largest and most complex structures ever welded.

You bet those electrodes have to be good—*better* than good—as near perfect as production tools can be made.

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The final proof of SMITHway Certified Electrodes *is* indeed *in production!* They are shop-tested and proved long before you get them. That's why they are *right*—why they are uniform in quality and characteristics—why they are able to deliver *more* good welds per man hour at the *least* possible cost.

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SMITHway A. C. Welding Machine saves power; eliminates arc blow.

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Holtkamp, Gene W. (B), 1135—3rd St., Oakland, Calif.
Hutton, E. D. (B), 2024 Bancroft Ave., San Leandro, Calif.
Longley, George P. (C), 40 San Pedro Rd., San Rafael, Calif.
Reich, Albert A. (B), 516 Harold St., Lodi, Calif.
Simatovich, A. P. (B), U. S. Maritime Comm., 14th & Franklin Sts., Oakland, Calif.

SYRACUSE

Saponaro, John (B), Utica Structural Steel, Inc., Utica, N. Y.
Tucker, Walter E. (B), Fitzgibbons Boiler Co., Oswego, N. Y.

TOLEDO

Dean, Wm. S. (C), 3102 Glenn St., Toledo 12, Ohio.
Fosnight, J. L. (C), U. S. Electric Welder Corp., 1224 W. Bancroft St., Toledo, Ohio.

WASHINGTON, D. C.

Hinchliffe, Virgil J. (C), 302 Boxwood Dr., P. O. Anacostia, 20 D. C., Morningside, Md.

WESTERN MASS.

Fordyce, Henry (B), 25 Gilman St., Holyoke, Mass.
Petrowsky, Stanley (C), 18 Lowell St., Worcester 3, Mass.
Randall, Robert (B), 1944 Northampton St., Holyoke, Mass.
Ulshoeffer, E. C. (B), 28 East St., Easthampton, Mass.

WESTERN NEW YORK

Meyer, Amel R. (C), 77 Unionvale Rd., Buffalo 21, N. Y.

WICHITA

Tritchler, Wayne C. (B), Commodore Hotel, Wichita, Kan.

NOT IN SECTIONS

Harper, Farrel R. (C), 227 Union Ct., Flint Hill Manor, Burlington, Iowa.
Choat, Howard N. (C), 1338—6th Ave., East, Twin Falls, Idaho.
Hile, L. V. (C), Box 413, Phillips, Tex.
Mullens, Wm. E. (B), Trinidad Leaseholds, Ltd., Pointe-Au-Pierre, Trinidad, B. W. I.
Waggott, John W. (B), 61 Herbert St., Walton, Liverpool, 9, England.
Hoover, Joseph F. (B), 116 Cahill Lane, Oak Ridge, Tenn.
Baines, Walter A. (B), 14 Park Row, Tredegar, Mon., South Wales, Great Britain.
Bahm, Floyd (B), 2021 Poplar St., Erie, Pa.
Rapley, Blake P. (B), International Petroleum Co. Ltd., Talara, Peru, S. A.

Members Reclassified

During Month of June

BIRMINGHAM

Gilley, Herman J. (from D to C), 5115 Ave. P, Birmingham 8, Ala.

BOSTON

Bain, Earle S. (from D to C), 180 Shaw Ave. Ext., N. Abington, Mass.
Ruel, Hubert N. (from D to C), 34 Chelmsford St., Dorchester 22, Mass.

BRUNSWICK

Brinson, Eugene A. (from C to B), W. A. 13, Apt. 647, 301 Union St., Brunswick, Ga.

CANTON

Aman, Dexter S. (from D to C), N. Main St., Navarre, Ohio.

CLEVELAND

Blasius, Peter F. (from D to C), 20370 Tracy Ave., Euclid 19, Ohio.

DETROIT

Withers, Frank J. (from C to B), 14189 Seymour Ave., Detroit 5, Mich.

HAWAII

Veteto, Paul, Jr. (from D to C), 319—6th St., Navy Housing, Honolulu 50, T. H.

MILWAUKEE

Robleski, Henry (from D to C), 514—42nd St., Kenosha, Wisc.

NEW JERSEY

Parker, Charles (from D to C), 9 Miller St., Newark 5, N. J.
Smith, P. L., Jr. (from D to C), 38 Mt. Prospect Ave., Belleville 9, N. J.

NORTHERN NEW YORK

Jacobs, Howland D. (from D to C), 105 Seward Pl., Schenectady 5, N. Y.

PHILADELPHIA

Pister, Charles (from D to C), 4 Park Ave., Norwood Pk., Norwood, Pa.

PORTLAND, ORE.

Terry, Frank F. (from C to B), 879 S. E. Sandy Blvd., Portland 14, Ore.

SAN FRANCISCO

Salatin, J. F., Lt. 0856537 (from D to C), c/o Postmaster, San Francisco, Calif.

SOUTH TEXAS

Rackley, Clyde L. (from D to C), Box 961, Beaumont, Tex.

WESTERN NEW YORK

Sage, Derreth C. (from D to C), Bolivar, New York.

NOT IN SECTIONS

Boggs, Jay S. (from D to C), 20-B Calhoun Homes, No. Charleston, S. C.
Somerville, William P. (from D to C) 305—2nd St., New Westminster, B. C.

SPOT WELDER CATALOGS

Following the recent issue of the 28-page "Light Type Bench Spot Welder" bulletin, featuring the complete line of small spot-welding machines from 1/4 to 3 kva., manufactured by the Eisler Engineering Co., Newark, N. J., extensively used for filament welding, radio, electronics, cathode ray tubes, etc., jewelry and wire welding, the company just published a new 58-page catalog No. CE-44W, entitled "Spot Welders," showing all types of standard and many special resistance welding machines, manufactured by the Eisler Engineering Co., in the capacity range from 3-kva. to heavy duty models up to 500-kva.

STEEL WELDING WIRE OUTPUT ROSE SHARPLY*

1943 Production Totaled 1,166,400,000 Lb.

Production of steel welding wire by the steel industry in 1943 rose approximately 45% above the 1942 figure for a record total of 1,166,400,000 lb.

The 1943 total was nearly two and one-half times the 1941 production of 453,120,000 lb. The 1942 output was 800,400,000 lb., more than three times the production in 1940 and almost double the output in 1941.

The sharp increase in the manufacture of welding wire in 1943 reflects the heavy production of war equipment of all kinds. Shipbuilding in particular has required large quantities of welding wire.

For each ton of finished steel produced last year, over 17 lb. of welding wire were made, compared with almost 13 lb. in 1942 and over 7 lb. in 1941.

* From *Steel Facts*, June–July 1944.

the new ACP *electrode*

. . . FOR SPEED WELDING IN ALL POSITIONS WITH A-C AND D-C REVERSE POLARITY

One of the most important welding developments in the past ten years . . . *it's the new ACP welding rod* . . . engineered and produced to meet the operator's demands of today and postwar for versatile performance and ease of handling. This new Westinghouse electrode simplifies slag removal . . . steps up production and quality welds in all positions.

Flexarc ACP Electrodes form a *light, porous slag* which is easily removed from each pass by light brushing. Delays to allow weld to cool for heavy brushing are eliminated. Operators will immediately sense a drive and penetration equal to, or better than, that obtained with direct current and corresponding all-position, direct-current electrodes.

ACP electrodes are especially suited for shipyard, piping and heavy fabrication work. Complete information, including application data, physical properties, and current ranges, is featured in the new ACP electrode Booklet, B-3353. Learn more about ACP . . . write today for your copy. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., Dept. 7-N.

J-21310

WESTINGHOUSE FLEXARC ELECTRODES AVAILABLE FOR PROMPT DELIVERY

- **ACP—AWS—Class E-6010-11 . . . for high-quality work on mild steels that are not readily positioned. a-c and d-c reverse polarity.**
- **AP . . . Class E-6010 . . . for speed welding in all positions with d-c reverse polarity.**
- **SW . . . Class E-6012-13 . . . for low-current all-position welding on mild steels . . . particularly adapted for welding light gauge steel.**
- **FP . . . Class 6012-13 . . . for high-speed general-purpose welding on low or medium carbon steels.**
- **DH . . . Class E-6020-30 . . . for high-current downhand welding on low and medium carbon steels.**

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PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

WELDERS AND ELECTRODES

SECTION ACTIVITIES

CHATTANOOGA

The Chattanooga Section closed this season's activities with an annual meeting Friday, June 23rd. At that time a dinner and entertainment were offered the members and their wives at the Chattanooga Golf and Country Club. A "small but select" gathering of 22 were in attendance and a good deal of fun and fine fellowship resulted. The dinner was served out on the veranda of the Club and the atmosphere and cool breezes were ideal for such a get-together. Later the group adjourned to one of the dining rooms indoors where a sound movie in technicolor was shown.

The officers for the coming year were installed at this meeting as follows: *Chairman*, Justin Brown, Chattanooga Boiler & Tank Co.; *Vice-Chairman*, Clarence Miller, Welding Gas Products Co.; *Vice-Chairman*, R. E. Brooks, Combustion Engineering Co.; *Secretary-Treasurer*, R. G. Wilson, National Cylinder Gas Co.

It is felt by the Chattanooga Section that they are making progress and new members are being gained slowly but consistently and high hopes were expressed all around for an even better season commencing next Fall.

CLEVELAND

The following officers have been elected by the Cleveland Section for the 1944–45 season: *Chairman*, Ross J. Yarrow, Republic Structural Iron Works; *Vice-Chairman*, John Ridenour, Standard Oil Co.; *Secretary-Treasurer*, A. Leslie Pfeil, Universal Power Corp.

COLUMBUS

The Columbus Section announces the election of the following officers and members.

Officers: Chairman, L. P. Wood, Curtiss-Wright Corp.; *Vice-Chairman*, R. D. Williams, Battelle Memorial Institute; *Secretary-Treasurer*, Geo. S. Herren, Seagraves Corp.

Executive Committee: R. P. Sharer, Geo. L. Geisler, J. H. Parker, E. W. Emig, V. H. Arts, C. W. Lakin.

J. R. Stitt of Columbus Section was elected Vice-President of the Columbus Technical Council of Engineers.

At the last regular meeting of the Section the following films were shown: Atomic Hydrogen Arc Welding, Welded Steel Tubes, and Army picture "Tarawa."

LOUISVILLE

A number of A.W.S. members of the Louisville Section attended the University of Louisville taking the U. S. Government sponsored course in Ferrous Metallurgy. An appropriate certificate for satisfactory completion was awarded to Howard C. Schank, Jesse W. Hardy, Charles Krupp, Frank E. Carroll, Theodore Lewis and Robert Lee Meredith, employees of The Jeffersonville Boat & Machine Co., also Edward L. Hahmann of Tube Turns, Inc.

The main objective of this course was to give the student fundamental principles and to train them in basic techniques, as they apply to industrial methods and processes, and to be immediately useful. The work was of college level. However, no credit toward a degree was given, but an appropriate certificate was issued as stated above.

NEW JERSEY

The following officers and members, Executive Committee and Chairmen, Special Committees have been elected by the New Jersey Section for 1944–45.

Chairman, G. W. Nigh, Tidewater Associated Oil Co.; *Vice-Chairman*, K. W. Horsman, Worthington Pump & Machine Co.; *Secretary-Treasurer*, F. G. Flocke, The International Nickel Co.

Executive Committee: J. Harold Bucknam, M. G. Elliot, William H. Hart, P. M. Mattern, Raymond E. Powell, M. F. Sheely, Thomas B. Smith, K. L. Walker, C. R. Weston, R. M. Wilson.

Chairmen of Special Committees: Program Committee, R. Pursell; Membership, Andrew C. Axtell; Advisory, F. C. Fyke, H. H. Moss, G. N. Bull.

NORTHERN NEW YORK

At a recent election the following officers were elected for the coming year: *Chairman*, H. S. Swan, American Locomotive Co.; *1st Vice-Chairman*, H. O. Westendarp, General Electric Co.; *2nd Vice-Chairman*, G. W. Garman, General Electric Co.; *Secretary-Treasurer*, R. S. Pelton, General Electric Co.

ST. LOUIS

400 members and guests attended the Annual Dinner Meeting of the St. Louis Section held on June 9th at the Statler Hotel Ballroom. One of the main features of the program was the presentation of the gavel by the retiring chairman to the new chairman and also the introduction of the newly elected officers and board members.

Some 35 or 40 member companies reserved full tables of 8.

The retiring chairman, E. F. Meier, of the Monsanto Chemical Co., very capably introduced the toastmaster, Jim Conzelman, who is assistant to the President of the St. Louis Browns and the American Investment Co. Jim Conzelman is extremely popular in the St. Louis area as well as other parts of the country for his brilliant activities and various sports, mainly football and baseball, both collegiate and professional. After introductions, Jim Conzelman gave a highly entertaining and informative talk, mostly concerning the amusing experiences which he has had through his association with the St. Louis Browns.

The main speaker of the evening, Bill Jack, of Jack and Heintz, Inc., Cleveland, gave a most brilliant performance in describing the history and growth of the Jahco Plant, including employee-management relations, present and postwar, and considerable detail concerning renegotiations. Mr. Jack held completely the interest of everyone in the room, and at the close of his speech, which was extemporaneous, everyone rose and applauded for a considerable length of time.

The St. Louis Section feel that they have accomplished a great deal in sponsoring a meeting of this type, as the amount of prestige gained thereby has grown to far-reaching proportions. The Section intend to do it again next year and feel that the attendance at regular monthly meetings will be increased, as the Section now has recognition which is greater than it has ever had before.

SAN FRANCISCO

The May Meeting of the AMERICAN WELDING SOCIETY, San Francisco Section, was held at El Jardin Restaurant, 22 California St., San Francisco, Calif., at 6:30 P.M., Chairman R. O. Waldman, presiding.

There were approximately 55 members and guests in attendance.

The meeting was addressed by H. W. Saunders, Air Reduction Sales Co. Mr. Saunders' talk was graphically illustrated by lantern slides, depicting the part which the Compressed Gas Industries have played and are playing in our efforts toward ultimate and complete victory.

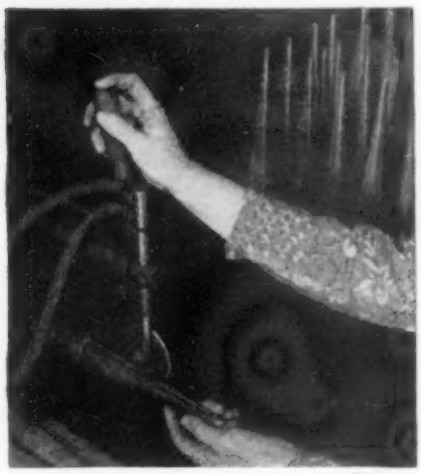
The meeting was then addressed by H. A. Folgner, Harman and Handy Products. Mr. Folgner's talk, which was also accompanied by lantern slides, opened our eyes to the multitude of applications of silver brazing, both in the war effort and in civilian industries.

The meeting adjourned at 10:05 P.M.

TIDEWATER

A new Section was organized in Portsmouth, Va., to be known as the Tidewater Section. The organizational meeting was held June 13th at 8:00 P.M. in the Fleet Reserve Hall, 305 High St., Portsmouth, Va.

AVIATION GAS STRAINERS *welded with* BOMB-SIGHT PRECISION



Exceptionally close tolerances and deep drawing accomplished in electrically welded strainers of Monel wire cloth

The *excellent fabricating and welding* qualities of Monel wire cloth are illustrated by these strainers for use in protecting military aircraft.

Consider these strict requirements:

The wire cloth must resist abrasion, corrosion, wear and abuse. The strainers must be fabricated to tolerances as exacting as plus .000 inch, minus .001 inch. (One, for fuel tank inlet, is produced by a five-inch deep draw!) In addition, the wire cloth must lend itself readily to welding for speedy production.

Such results are obtained with Monel. Its high strength, stiffness and ductility assure uniformly woven cloth, and proper forming. Its weldability permits simplicity of design and speed in fabrication. Together these factors permit the Michigan Wire Cloth Co., to turn out the precision made strainers required by aircraft.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

MONEL (Ni MONEL)

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

TOP PHOTO
Electric welding of a Monel cone strainer, used in the nozzle of fuel hoses for handling aviation gasoline. Note how slotted metal sleeve holds wire cloth cone in shape for welding wheel.

1.
Fuel Tank Inlet Strainer made from 5 mesh Monel cloth, .023" diameter wire with brass reinforcements.

2. and 3.
Monel Fuel Line Strainers made from 60 x 50 mesh, .008" diameter wire with brass flange. Larger has brass ring and phosphor bronze reinforcement strips.

4. to 7.
Finger Strainers for gas tank outlet. Made from 18 mesh Monel cloth, .018" diameter wire with brass ferrules and collars.

The meeting was called to order by C. O. Barham, temporary chairman, who informed the group that the meeting was for the purpose of electing officers for the new Section. After reading a letter from the SOCIETY Headquarters authorizing the organization of this Section, the officers were elected as follows.

Chairman, C. O. Barham; *Vice-Chairman*, E. S. Nance; *Secretary-Treasurer*, E. C. Rowell.

Directors (2 years), W. C. Smith, P. C. Greene, A. C. Love, R. S. White; (1 year), H. R. Floyd, C. F. Grubbs, M. L. McCarty, M. Friedman.

Membership Committee, A. C. Love, C. A. Breeze, I. I. Bunney, Wm. St. J. Doar, H. G. Schwerin, W. D. Sprouse, Martin Friedman, J. Shadonix.

Entertainment Committee, E. S. Nance, A. C. Bergh, S. T. Sumner, Joseph White, C. F. Grubbs.

Press Reporter, C. A. Breeze.

H. W. Lawson, Vice-President, Middle Eastern District, gave a most interesting talk on the Aims, Benefits and Achievements of the SOCIETY, and also explained the different classes of membership.

Dr. John W. Miller of the Reid Avery Co., Baltimore, Md., gave a lecture on "Welding Electrodes" which was very interesting as well as educational.

The meeting was then opened for discussion and many questions pertaining to welding and welding electrodes were asked and ably answered by Dr. Miller.

The Chairman then informed those present that the regular meeting of the Tidewater Section would be held the 2nd Tuesday of each month at 7:30 P.M. in the Fleet Reserve Hall, 305 High St., Portsmouth, Va., beginning the 2nd Tuesday in September.

TOLEDO

The annual meeting of the Toledo Section on June 20th finished the 1943–44 season to the full satisfaction of those present. There were thirteen members and eleven guests.

The following newly elected officers were introduced:

Chairman, Edwin Nafzger, Toledo Steel Tube Co.; *1st Vice-Chairman*, John C. Geisland, City Auto Stamping Co.; *2nd Vice-Chairman*, Edward L. Baldwin, Toledo Shipbuilding Co.; *Secretary-Treasurer*, Lloyd Bersticker, Toledo Board of Education.

A letter received from the former chairman, Lorenzo Kennon, who is now a member of the Los Angeles Section, was read, expressing his appreciation for the Past-Chairman's Pin, presented to him by the Chairman of the Los Angeles Section at their June meeting, for the Toledo Section.

The technical session following was one of the best and most enlightening of the past season. Dr. Harry B. Osborn, Jr., the speaker, is director of research of the Tocco Division of Ohio Crankshaft Co., Cleveland. Dr. Osborn was an excellent speaker. He spoke on "Induction Heating, the Tocco Process at War Today, at Peace Tomorrow." Slide films were used to show the different processes, installations and parts covered by his talk.

The first meeting of the new season is scheduled for the third Tuesday in September.

WESTERN MASSACHUSETTS

At a meeting of Directors of the Section held on June 14th at the home of the new Chairman, Emil Stolte, the results of the election of officers for 1944–45 were announced as follows:

Chairman, Emil Stolte, Westinghouse Elec. & Mfg. Co.; *Vice-Chairman*, R. W. Gamache, U. S. Armory; *Treasurer*, H. W. Walsh, Worthington Pump & Machine Corp.; *Secretary*, E. J. Peltier, Westinghouse Elec. & Mfg. Co.

Directors at Large (2 years), R. T. Perrine, Harold Wrigley, Henry Fordyce; (1 year), W. A. Emery, F. H. Jones, M. F. Stray, C. R. Black.

The following committees were appointed: Program, W. A. Emery, *Chairman;* Publicity, R. W. Gamache, Alexander Allen; Membership, F. W. Taft, H. S. Hill, L. Potorski, R. T. Perrine, G. E. Stanley.

Mr. Emery outlined his plans as Chairman of the Program Committee. Nine meetings are scheduled for the coming season. These meetings will be held in Holyoke and Springfield.

Current Welding Literature

(*Continued from page 730*)

Shipbuilding. British Shipbuilding Developments. Mar. Eng. & Shipg. Rev., vol. 49, no. 5 (May 1944), pp. 180–183.

Shipbuilding. Flame-Cutting in Shipyard, G. M. Boyd. Shipbldg. & Shipg. Rec., vol. 63, no. 10 (Mar. 9, 1944), pp. 229–231; no. 11 (Mar. 16), pp. 251–253.

Shipbuilding. Some Notes on Welded Ship Construction, J. Turnbull. Shipbldg. & Shipg. Rec., vol. 63, no. 16 (Apr. 20, 1944), pp. 372–375.

Shipbuilding. Time Study of Manual Electric Welding in Shipbuilding, H. H. Hagan. Instn. Engrs. & Shipbldrs. in Scotland—Trans., vol. 87, pt. 6 (Apr. 1944), pp. 128–139; (discussion), 139–144.

Shipbuilding. Welded Ship Construction, J. Turnbull. Mech. World, vol. 115, no. 2991 (Apr. 28, 1944), p. 480.

Shipbuilding. Welding of Tanker Seams for Final Hull Assembly, A. Von Drachenfels. Log, vol. 39, no. 3 (Mar. 1944), pp. 74–76.

Ships, Pipe Lines. Welding-Fittings Reduce Bulk and Weight, T. H. Pike, Jr. Pac. Mar. Rev., vol. 41, no. 4 (Apr. 1944), pp. 84–85, 98.

Shipyards, United States. Indoor Ship Factory, A. B. Newell. Motorship, vol. 29, no. 4 (Apr. 1944), pp. 302–304, 351.

Steel Castings. Repair Welding Heavy Cylinder Casting, J. R. Mitchell. Industry & Welding, vol. 17, no. 5 (May 1944), pp. 32–33, 37–38.

Steel Manufacture. Bessemer Steel Coming Back Into Its Own. Blast Furnace & Steel Plant, vol. 32, no. 4 (Apr. 1944), pp. 68, 71, 72.

Structural Steel. Welding in Postwar Steel Construction, L. Grover. Iron Age, vol. 153, no. 24 (June 15, 1944), pp. 71–73.

Tanks, Military. Production of Welded Hulls and of Sub-Assemblies for Wheeled Tanks. Machy. (Lond.), vol. 64, no. 1630 (Jan. 6, 1944), pp. 1–6; no. 1631 (Jan. 13), pp. 29–31.

Tanks, Military. Transition from Riveted to Welded Tank Construction, W. Osha. Army Ordnance, vol. 26, no. 142 (Jan.–Feb. 1944), pp. 120–122.

Tubes, Spinning. Flame-Spinning Process, T. McElrath, Jr. Steel, vol. 114, no. 22 (May 29, 1944), pp. 84–85, 119–120.

Welded Steel Structures, Belgium. Welding Evolution in Construction of Bridges and Steel Structures in Belgium—II, A. Spoliansky. Welder, vol. 12, no. 83 (Jan.–Dec. 1943), pp. 320–322, 326–329.

Welders, Training. Tacking Problems in Shipbuilding, V. G. Josselyn. Mar. Eng. & Shipg. Rev., vol. 49, no. 3 (Mar. 1944), pp. 155–156.

Welding. Application of Scientific Welding, C. W. Brett. Civ. Eng. (Lond.), vol. 38, no. 450 (Dec. 1943), pp. 279–280.

Welding Engineer—What's His Job, W. J. Brooking. Welding Engr., vol. 29, no. 2 (Feb. 1944), pp. 50–51; no. 3 (Apr.), pp. 42–44; no. 5 (May), pp. 42–44.

Welds. Inspection of Structural Welding, T. R. Higgins and W. S. Lee. Bldg. Standards Monthly, vol. 13, no. 4 (Apr. 1944), pp. 7–11; (discussion), 11–14.

Welds. Non-Ferrous Chemical Plant, W. K. B. Marshall. Metal Industry (Lond.), vol. 64, no. 14 (Apr. 7, 1944) pp. 210–213; no. 15 (Apr. 14), pp. 226–228.

Welds, Testing. Investigation Into Influence of Welding Conditions on Distribution of Shear Strength of Spot Welds in Various Aluminum Alloys, F. Bollenrath and V. Hauk. Sheet Metal Industries, vol. 19, no. 204 (Apr. 1944), pp. 689–693, 704; no. 205 (May), pp. 883–886, 888.

Welds, Testing. Strength of Arc Welded Seams, H. Cornelius and F. Ballenrath. Engrs.' Digest (British Edition), vol. 5, no. 2 (Feb. 1944), pp. 51–53; see also Engrs.' Digest (American Edition), vol. 1, no. 4 (Mar. 1944), pp. 249–251.

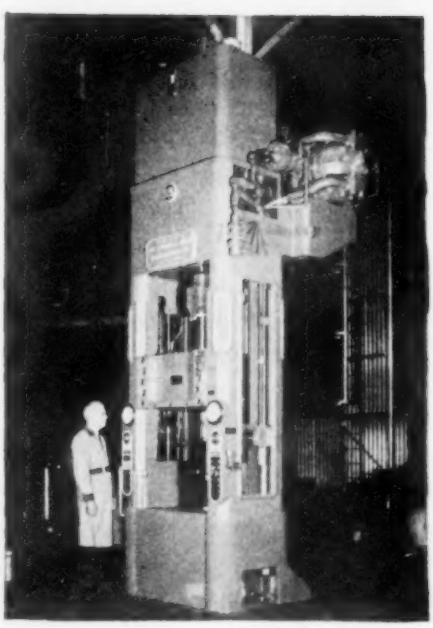
Welds. Welded Joint in Non-Ferrous Chemical Plant, W. K.B. Marshall. Indus. Chemist, vol. 20, no. 231 (Apr. 1944), pp. 171–181.

Welds, X-Ray Analysis. Radiography Applied to Welding, L. W. Ball. Iron Age, vol. 153, no. 21 (May 25, 1944), pp. 54–58.

THIS HELIXAUST MANIFOLD for diesel engines, fabricated by Dayton Fabricated Steel Co., increases engine efficiency by reducing back pressure. 3/16″ fillet welds are made with Murex Type FHP Electrodes, selected because of their excellent "hot" rod characteristics. All-position Vertex rods are used for the circumferential butt welds.

INSPECTING MUREX ELECTRODES. Careful production control—from raw materials to packing—is one of the reasons for uniform results with Murex.

THE DRAFT SILL ASSEMBLY of a freight car is being welded with Murex Electrodes in the plant of Pullman-Standard Car Manufacturing Company. Downhand rods are used because they are ideal for long, horizontal fillets and deposit sound X-ray clean weld metal at a rapid rate.



ARC WELDING, with Murex Electrodes, speeds the fabrication of cartridge case drawing presses for The Hydraulic Press Manufacturing Company. Instead of using steel castings throughout (the conventional method), the cylinder, slide and numerous other parts are arc welded. Vital production time is saved and the company is not dependent on outside casting facilities. Positioning equipment permits the use of "hot," downhand Murex Electrodes, resulting in fast deposition, low cost and sound, X-ray clean welds.

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Specialists in welding for nearly forty years. Manufacturers of Murex Electrodes for arc welding, and of Thermit for repair and fabrication of heavy parts.

TENTATIVE PROGRAM

TWENTY-FIFTH ANNUAL MEETING AMERICAN WELDING SOCIETY OCTOBER 16–19, 1944

HOTEL CLEVELAND, CLEVELAND, OHIO

MONDAY, OCTOBER 16th, Morning—9:30 A.M.

OPENING SESSION

Chairman—DAVID ARNOTT
President, American Welding Society

Vice-Chairman—E. V. DAVID
Chairman, Convention Committee

PRESENTATION OF MEDALS AND PRIZES

WELDING AIDS THE WAR EFFORT

Welding as an Aid in Shipbuilding Construction, by ADMIRAL H. L. VICKERY, U. S. Maritime Commission

Welding as an Aid in the Fabrication of Ordnance Equipment, by COL. S. B. RITCHIE, Office, Chief of Ordnance

Welding in Aircraft Construction, by W. B. STOUT, Consolidated Vultee Aircraft Corp.

Monday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

WELDING AND CUTTING IN HEAVY INDUSTRIES

Chairman—R. J. YARROW,
Republic Structural Iron Works

Vice-Chairman—J. M. DRISCOLL,
Air Reduction Sales Co.

Heavy Oxyacetylene Cutting
by G. L. WALKER and H. G. HUGHEY, Air Reduction Sales Co.

Steel Mill Maintenance
by E. W. GRUBER, Wheeling Steel Corp.

Unusual Applications of Gas Cutting in Ordnance Fabrication
by C. M. UNDERWOOD, Northern Ordnance, Inc.

RAILROAD AND TRANSPORTATION

Chairman—J. W. SHEFFER,
American Car and Foundry Co.

Vice-Chairman—A. G. OEHLER,
Associate Editor, Railway Age

Welding of Aluminum Tank Cars
by A. H. WOOLLEN, Railroad Sales, Aluminum Co. of America

Railroad Maintenance Welding
by CLAY W. ROBERTS, The Pennsylvania Railroad

Railroad Welding
by JOHN McMULLEN, Erie Railroad Company

WELDABILITY

Chairman—A. B. KINZEL,
Union Carbide & Carbon Corp.

Vice-Chairman—C. H. JENNINGS,
Westinghouse Electric & Mfg. Co.

Discussion Weldability of Manganese Steel
by W. B. BROOKS, Cramp Shipbuilding Co.

High Tensile Manganese Silicon Steels for Welded Fabrication
by G. G. LUTHER and F. H. LAXAR, Naval Research Lab.

The Bead-Weld Nick-Bend Test for Ductility
by C. E. JACKSON and G. G. LUTHER, Naval Research Lab.

The Influence of Minor Variables of Weldability
by R. D. STOUT, S. S. TÖR and G. E. DOAN, Lehigh University

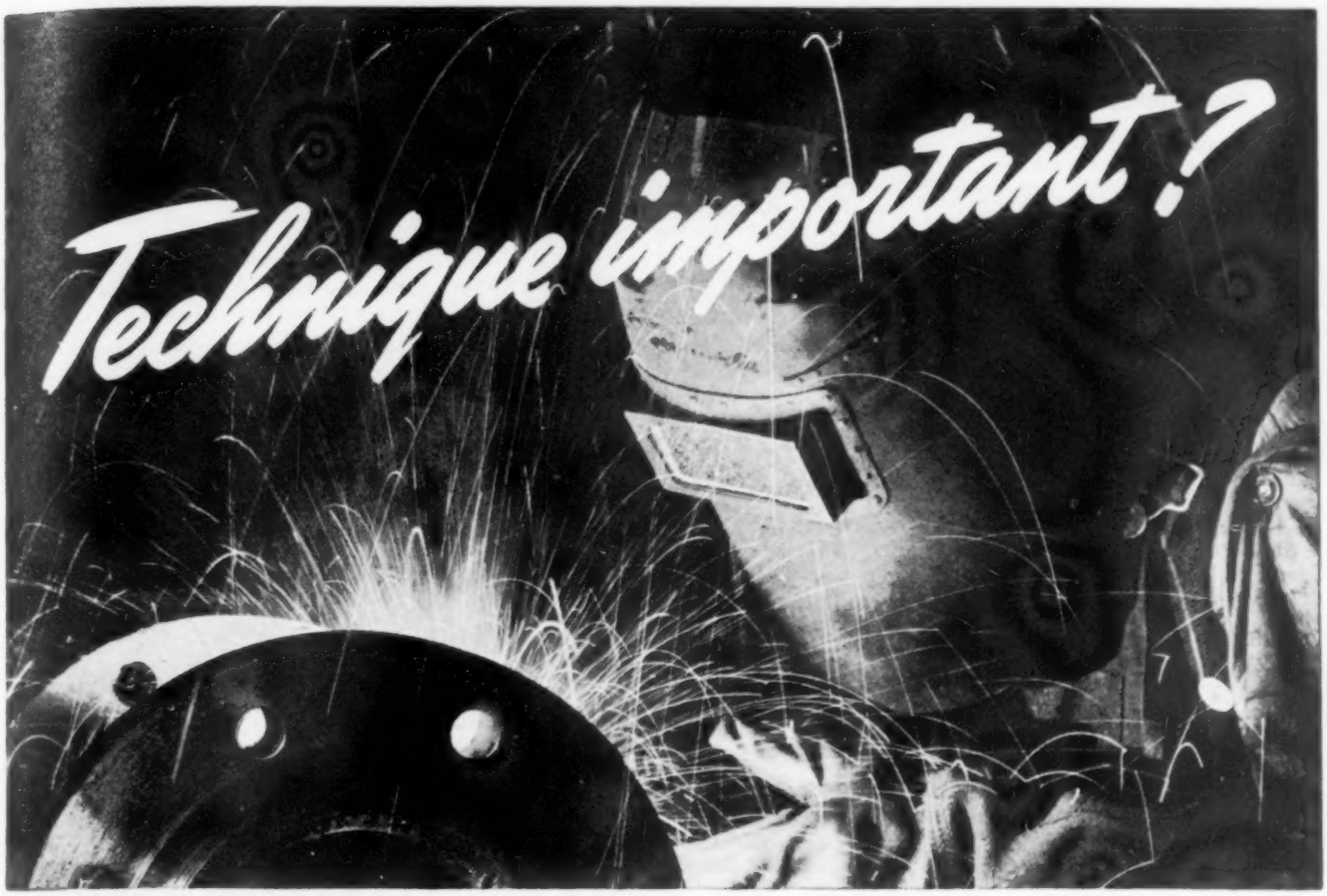
Monday Evening—8:00 P.M.

ADAMS' LECTURE

Chairman—WENDELL F. HESS,
Rensselaer Polytechnic Institute

Vice-Chairman—R. H. ABORN,
United States Steel Corp.

Solid Phase Welding by DR. A. B. KINZEL, Union Carbide and Carbon Corp.



Sure!...but it's a big help when you know your steel

ANY professional welder knows how important to his job is the right choice of steel. Once you have what you need, with full knowledge of its welding characteristics, you are well on your way to a successful result.

That's an advantage which comes when you work with U·S·S Rolled Steels. For if there is anything you haven't learned about their welding characteristics and the best technique to use with them, we can quickly tell you. Countless manufacturers have found this an invaluable aid.

There is little about welding U·S·S Rolled Steels our technical staff hasn't learned. We have made, and keep making, an infinite variety of tests. These steels are the product of our own research and facilities. We are as thoroughly experienced with their welding behaviour as with their quality.

For the security and satisfaction they can surely give you, look to U·S·S Rolled Steels. And for advice and counsel in respect to your welding needs in connection with them you may call on us freely.

U·S·S Rolled Steels for Welding Include:

U·S·S High Strength Steels to resist corrosion and increase strength without adding weight.

U·S·S Copper Steels to give twice the atmospheric corrosion resistance of regular steel at little additional cost.

U·S·S Hot-Rolled and Cold-Rolled Steels to provide the basic advantages of steel, plus maximum economy in accordance with the requirements of each job.

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COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York

UNITED STATES STEEL

TUESDAY, OCTOBER 17th, Morning—9:30 A.M.

THREE SIMULTANEOUS SESSIONS

RESISTANCE WELDING

Chairman—L. C. BIBBER, Carnegie Illinois Steel Corp.

Vice-Chairman—G. N. SIEGER, S.M.S. Corp.

Spot Welding Machines for Heavy Gauges of Ferrous and Non-Ferrous Metals
by MARIO SCIAKY, Sciaky Bros.

Heat Transfer Across Contact Surfaces
by W. B. KOUWENHOVEN, Dean, School of Engineering, Johns Hopkins University

Problems in Spot Welding Heavy Mild Steel Plate
by F. R. HENSEL, E. I. LARSEN and E. F. HOLT, P. R. Mallory & Co., Inc.

RESEARCH

Chairman—S. L. HOYT, Battelle Memorial Institute

Vice-Chairman—R. E. KINKEAD, Consulting Welding Engineer

The Effect of Postheating in Welding Medium Alloy Steels
by M. A. PUGACZ and G. J. SIEGEL, Naval Research Laboratory

Stress Relieving Study
by PROF. J. R. STITT, Ohio State University

The Effects of Metallurgical Changes Due to Heat Treatment Upon the Fatigue Strength of Carbon-Steel Plates
by W. H. BRUCKNER and W. H. MUNSE, University of Illinois

STRUCTURAL

Chairman—A. S. LOW, The Austin Co.

Vice-Chairman—J. F. MAINE, Republic Structural Iron Works

Standard Details for Welded Building Construction
by H. W. LAWSON, Bethlehem Steel Co.

Field Welded Pressure and Variable Volume Storage Tanks
by FRED L. PLUMMER, Hammond Iron Works

Rigid Frame Structure
by MARTIN P. KORN

Tuesday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

RESISTANCE WELDING

Chairman—R. E. POWELL, Western Electric Co.

Vice-Chairman—H. C. COGAN, National Electric Welding Machines Co.

Low Reactance Cable for Resistance Welders
by MYRON ZUCKER, Mackworth G. Rees, Inc.

The Flash Welding of Alloy Steels—Welding Techniques and Variables
by J. J. RILEY, **Metallurgical and Physical Characteristics,** by J. C. BARRETT, Taylor-Winfield Corp.

Small Portable Condenser Welding Set
by E. M. CALLENDER, E. G. Budd Mfg. Co.

RESEARCH

Chairman—H. C. BOARDMAN, Chicago Bridge & Iron Co.

Vice-Chairman—G. V. SLOTTMAN, Air Reduction Sales Co.

Some Recent Developments in Stainless Steel Welding
by D. L. MATHIAS, Metal & Thermit Corp.

Bi-axial Fatigue Strength of Low-Carbon Steels
by GEORGE K. MORIKAWA and LeVAN GRIFFIS, Illinois Institute of Technology

Intergranular Corrosion of Stainless Steel Welds
by WM. T. TIFFIN, University of Oklahoma

Weldability Tests of Cast Steel
by C. E. JACKSON and F. S. McKENNA, Naval Research Lab.

SHIPS

Chairman—J. L. WILSON, American Bureau of Shipping

Vice-Chairman—S. A. MIDNIGHT, American Ship Building Co.

Controls Required for Safe and Economical Construction of Welded Ships
by D. G. MAXSON, Welding Consultant, Marinship Corp.

Technical Control of Welding in Ship Construction
by M. H. MacKUSICK, California Shipbuilding Corp.

Evolution of Welding in Ship Building
by M. N. MALTSEFF, Western Pipe and Steel Co.

Multiple and Stack Machine Cutting
by A. H. YOCH, Air Reduction Sales Co.

Tuesday Evening—8:00 P.M.

UNIVERSITY RESEARCH CONFERENCE

WEDNESDAY, OCTOBER 18th, Morning—9:30 A.M.

TWO SIMULTANEOUS SESSIONS

AIRCRAFT

Chairman—G. S. MIKHALAPOV, National Research Council

Vice-Chairman—C. W. DODGE, Sciaky Bros.

Aircraft Welding
by H. O. KLINKE, Republic Aviation Corp.

Helium Shielded Arc Welding of Exhaust Collector Rings
by FRANCIS H. STEVENSON, Lockheed Aircraft Corp.

Multi-Arc Welding of Aluminum Alloys
by M. R. RIVENBURGH and C. W. STEWARD, Curtiss-Wright Corp.

Arc Welding in Aircraft
by H. E. SHAY, Douglas Aircraft Co., Inc.

RESEARCH

Chairman—ISAAC HARTER, The Babcock & Wilcox Co.

Vice-Chairman—E. R. SEABLOOM, Crane Co.

Weldability-as-Rolled vs. Heat-Treat High Strength Constructional Steels
by LT. S. A. HERRES and W. L. WARNER, Watertown Arsenal

Stress Relief of Welded Joints
by J. K. McDOWELL, and PAUL C. CUNNICK, Lt. Col. Ordnance Dept., Rock Island Arsenal

Development and Application of Modern Heavy Coated Arc Welding Electrodes
by D. C. SMITH and W. G. RINEHART, Harnischfeger Corp.

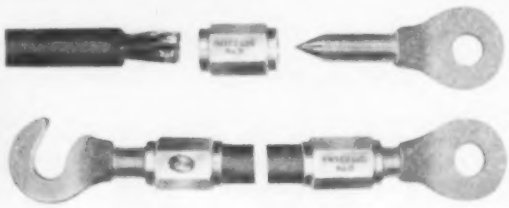
DON'T LET POOR CONNECTIONS

put "the Lug"

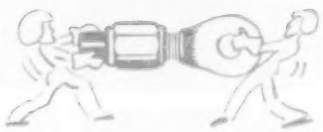
ON YOUR PROFITS

CONNECT YOUR WELDING CABLES WITH

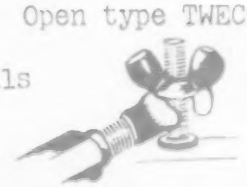
TWECOLUGS



TWECOLUGS are made in three sizes to connect No. 4 through 4/0 Welding Cable.

The TWECOLUG principle is a tapered screw terminal wedging into a hollow seated body giving a POSITIVE CONNECTION  WITHOUT SOLDERING. And in case of cable breakage, field installation is quickly made. Just insert cable strands into hollow seated body and turn screw into nut held stationary. New Beveled side hole in lug nut prevents cable turning or backing out when installing.

TWECOLUGS are made of Special High Copper Alloy. Brass body of lug is hexagon for ease of holding while installing. And TWECOLUGS can take it! They're made heavy enough to stand abuse and will last the life of an ordinary welding machine.

TWECOLUGS are of two types - open type and hole type. Open type TWECOLUGS permit easy installation on machine terminals  without completely removing wing nuts. "Connect with TWECO"

TWECO manufactures the only complete line of Welding Electrode Holders, Ground Clamps, Cable Connectors, and Cable Lugs. Write for Bulletin No. 1943-G.

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Wednesday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

AIRCRAFT

Chairman—G. O. HOGLUND, Aluminum Co. of America
Vice-Chairman—E. S. JENKINS, Curtiss-Wright Research Lab.

The Geometry of the Spot Welding Tip and Its Relation to Tip Life
by E. D. CRAWFORD and C. W. STEWARD, Curtiss-Wright Corp.

Survey of Cleaning Practices for Spot Welding Aluminum Alloys
by F. M. MORRIS, Kaiser Cargo, Inc., Fleetwings Div.

An Evaluation of Process Control of Aircraft Welding
by P. H. MERRIMAN, The Glenn L. Martin Co.

Gas Shielded Arc Welding
by F. A. WASSELL, General Electric Co.

MACHINERY

Chairman—A. E. GIBSON, Wellman Engineering Co.
Vice-Chairman—R. J. KRIZ, The James H. Herron Co.

Production Problems and Production Control
by E. C. BREKELBAUM, Harnischfeger Corp.

Routine Inspection and Salvage of Machinery Weldments — Rough, Partially Machined and Machined
by JAMES W. OWENS, Fairbanks, Morse & Co.

Welded Jigs and Fixtures
by A. N. KUGLER, Air Reduction Sales Co.

Design of Welded Machinery
by JOHN MIKULAK, Electric Machinery Manufacturing Co.

PIPING AND PRESSURE VESSELS

Chairman—A. C. WEIGEL, Combustion Engineering Co.
Vice-Chairman—R. W. EMERSON, Pittsburgh Piping & Equipment Co.

Pressure Vessel Welding
by EDWARD B. McGUIRE, Hamler Boiler & Tank Co.

Normalizing of Welds in Carbon-Molybdenum Steel Pipe by 60-Cycle Induction Heating
by I. A. ROHRIG and D. H. COREY, The Detroit Edison Co.

Properties of Welded Joints Between Dissimilar Metals
by E. C. CHAPMAN and R. E. LORENTZ, Combustion Engineering Co.

Oxy-Acetylene Pressure Welding
by A. R. LYTLE, Union Carbide & Carbon Res. Labs.

Wednesday Evening—6:30 P.M.

Section Officers Dinner and Conference

THURSDAY, OCTOBER 19th, Morning—9:30 A.M.

TWO SIMULTANEOUS SESSIONS

FOUNDRY

Chairman—L. A. DANSE, Cadillac Motor Car Div.
Vice-Chairman—AUSTEN J. SMITH The Lunkenheimer Co.

Arc Welding Practices in the Steel Foundry
by FRANK KIPER and LAWRENCE GABES, Ohio Steel Foundry

Machine Cutting of Risers, Flame Scarfing to Remove Padding, and Flame Gouging to Remove Webs and Defects
by G. E. BELLEW, Air Reduction Sales Co.

Repair of Castings
by L. A. DANSE, Cadillac Motor Car Div., General Motors Corp.

MISCELLANEOUS

Chairman—W. E. CRAWFORD, A. O. Smith Corp.
Vice-Chairman—A. L. PFEIL, Universal Power Corp.

Joining at Low Temperatures
by W. D. WASSERMAN, Eutectic Welding Alloys Co.

A Method for Measuring the Bond Strength of Sprayed Metal Coatings
by KENNETH WILSON, Metallizing Engineering Co.

How Much Ductility Is Necessary in a Structure
by W. J. CONLEY, Lincoln Electric Co.

Thursday Afternoon—2:00 P.M.

Business Meeting

3:00 P.M.

Board of Directors Meeting

ANNUAL MEETING, A. W. S.

HOTEL CLEVELAND

CLEVELAND, OHIO

Make Reservations Early

Write to
Housing Committee
National Metal Congress
1604 Terminal Tower Bldg.
Cleveland 13, Ohio

Mention American Welding Society